DynaPump

Installation Manual

for the D5 Pumping Unit System

Document # MAN-INST-001 **Rev D** **Issue Date: October 22, 2010**

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REVISION RECORD

REV	DATE	SECTION	DESCRIPTION
A	5-01-09	-	Initial Release
B	6-10-09	5 App A App B	Page 21: Update crane selection criteria (step 2) Page 22: Add step for oil check in CWT site glass (step 4) Figure A-2: Replace pumping unit figure with current Figure B-1: Update Installation Checklist to add item 42
C	10-01-10	4 4 4 4 4 A B	Page 3: Change part number for installation & interface kit Page 4: Corrected dimension of concrete piers Pages 9,12-15: Update pumping unit components Pages 23-28: Add new section: “Pre-installation Well Head Verification” Pages 30-32: Update cylinder alignment requirements Page A-3: Corrected dimensions on Figure A-3 Pages B-2, B-3: Update Installation Checklist
D	10-22-10	3 4 C	Pages 6-8: Update tools and special equipment Page 41: Add external shutdown circuitry option Add Appendix C for historical configurations

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Section 1. Introduction

The ***DynaPump*** system is comprised of two basic components: the Pumping Unit, and the Power Unit. Figure A-1 shows an installed unit.

The Pumping Unit is comprised of a single hydraulically actuated oil-filled cylinder, assisted by one or two nitrogen-filled counterweight units, which work to apply the large up/down forces required at the well site. The technology incorporates real-time pump-off controller logic and provides real-time monitoring of well and/or pump performance status.

The Power Unit is the control center that provides the ability to convert electrical energy to hydraulic power and to control pump stroke as needed to provide optimum pumping efficiency.

Scope of Document

This document is broken down into several sections:

Section 1 - Introduction
Section 2 - Site Preparation
Section 3 - Tools and Special Fixtures Required
Section 4 - Unpacking and Pumping Unit Preassembly
Section 5 - Installation
Section 6 - Dynapump Service
Appendix A - Site Layout and Installation Drawings
Appendix B – Installation Checklist
Appendix C – Historical Configurations

Description of Basic Components

Pumping Unit

The Pumping Unit stands over the wellhead and attaches to the polished rod by means of a carrier bar. The Pumping unit comes in various sizes, depending on the maximum load likely to be encountered. The Model 5 Pumping Unit is designed for a maximum lifting load of 15,000 pounds, and provides a maximum stroke of 168 inches. The Unit is comprised of a patented triple chamber hydraulic cylinder, heavy duty structural base, two large cylinders containing nitrogen gas under pressure, and a pulley/cable lift mechanism which doubles sucker rod stroke relative to cylinder travel.

The nitrogen gas supply is connected to the cylinder counterweight chamber and serves as a counterbalance, basically to offset the rod weight and a portion of the fluid load. The counterbalance lift force can be adjusted at the well simply by adjusting the pressure of the gas in the storage cylinders. The direction and speed of the pump is then controlled by sending hydraulic fluid under pressure to either the up or the down chambers of the cylinder.

Since the pump is computer controlled, the speed and stroke limit can be independently established in both directions, thereby allowing for fast up strokes and slower down strokes. This feature greatly increases pumping efficiency for deep wells.

The pump utilizes many feedback mechanisms to provide optimum stroke control and full monitoring of well and pump conditions. Feedback sensors on the pump include a linear sensor to measure stroke position and a proximity switch to detect a possible cable break.

The Pumping Unit is mounted on a skid system that allows the pump to be retracted from the wellhead without requiring it to be disassembled. This feature allows maintenance crews to retract the pump using a winch in the event that maintenance is required on the well.

The unit consists of these assemblies:

- D5 - Pumping Unit Assembly
- K851 (E15A/E25A) and K854 (E40A)- Interface Kit
- K903 – General Installation Kit
- P601 – Piers Installation Kit
- P611 (E15A/B, E25A/B) or P612 (E40A) – Base Installation Kit

Power Unit

The Power Unit provides the driving force and control for the Pumping Unit. It is comprised of two major components: a Hydraulic Pump System, and a Control & Communications Center. The Hydraulic Pump System includes electric motors which drive fixed displacement pumps. The system includes a sealed hydraulic reservoir and various valves and sensors that allow the patented triple chamber cylinder to function correctly. The Hydraulic Pump System is connected to the Pumping Unit by means of two primary high-pressure hoses and four secondary control/feedback hoses.

The Control and Communications Center consists of solid-state electronics and motor controllers, which are designed for maintenance free operation. The electronics include computer controls that allow for the pump to be controlled by feedback for precise operation of stroke speed and position. The computer is also designed to communicate externally by means of a modem, a radio transmitter, or by using a direct telephone line. This allows the pump to be remotely monitored and controlled.

Power Unit Assemblies are as follows:

Part Number	Description	Motor HP	Input Voltage	Phase
E15A	Power Unit 15HP/480VAC/3PH	15	480	3
E25A	Power Unit 25HP/480VAC/3PH	25	480	3
E40A	Power Unit 40HP/480VAC/3PH	40	480	3

Section 2. Site Preparation

This section discusses how to prepare the well site for Dynapump equipment.

⚠ Safety Precautions

Observe the following ***safety precautions***:

- When hoisting or moving components or assemblies, always use a crane or forklift rated for the load being lifted or supported.
- Personal safety equipment should be worn (e.g. hard hat, steel-toe shoes, boots, etc.)

Dynapump pumping unit equipment is mounted on a series of four rectangular concrete platforms, referred to as piers. There are three piers for the pumping unit, and one for the power unit.

The three pumping unit piers are dimensioned 18" x 18" x 131" and are positioned at a pre-established distance from each other in accordance with Figure A-3. The power unit pier is dimensioned 108" x 96" and is placed 2 to 10 inches from the pumping unit pier as shown in Figure A-3.

After the piers have been positioned, mounting skids and the pumping unit itself are carefully aligned over the piers and then secured.

Figure 1 shows the relative placement of the piers, skids and pumping unit.

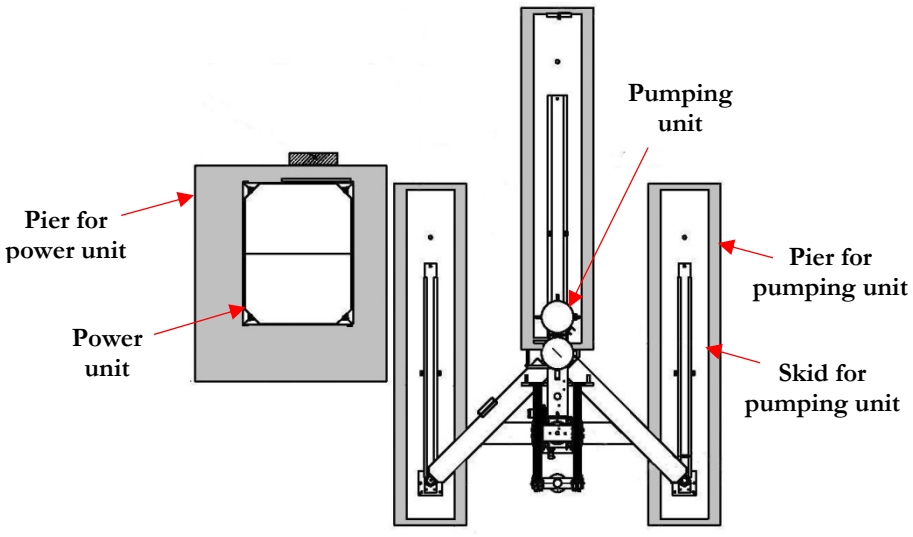


Figure 1. Relative Positioning of Piers, Skids and Pumping Unit

Piers Setup

The foundation that equipment is mounted over is typically pre-cast per Dynapump requirements, but also may be poured in place.

Perform the following steps:

1. Grade the site (approx. 25' x 25') and scrape all dirt/debris off existing well pad or level nominal ground level.
2. Provide adequate drainage by allowing excess water to drain. Poor drainage may result in the foundation settling unevenly, causing undue stresses in the foundation. This may cause pump misalignment after a period of time.
3. Excavate an area deep enough to position pre-cast concrete piers per the layout requirements. Foundation design/soil improvement is based on soil conditions at the well site, and the owner asumes full responsibility of the design/quality of the foundation.

Figure 2. Piers Setup

4. Add enough aggregate base to create a height of 36 inches between the wellhead and the top of the nominal pier level (see Figure A-2). The minimum height will assure full stroke length of the pumping unit.
5. Lower the pre-cast piers into the aggregate base using a crane or other hoist equipment (see Figure 2).
6. When finalizing the pier placement, verify that no concrete material hangs over the aggregate soil unsupported, and that the pumping unit will be able support full load bearing capability from the pumping unit. Site layout is based upon soil bearing strength of 6000 psf.
7. Position the pad in accordance with Figure A-3.

Skid Installation and Pumping Unit Placement

Skid mounting and pumping unit site installation must be performed at the same time to assure accuracy in equipment placement. The paragraph in Section 5 "Installation" titled, "Skid Unit Installation and Placement of the Pumping Unit" describes this procedure.

Section 3. Tools and Special Equipment

This section lists required tools and special fixtures required for assembly.

The following provides a list of equipment and tools needed to complete assembly of the DynaPump Unit. Most of these tools should be available locally. If tools are unavailable, please contact your DynaPump sales representative for a quotation on a particular item or items.

Recommended Tools

- Channel locks – ranging from 6.5-inch, 10-inch and 20-inch.
- End wrench set, standard sizes, US and Metric
- Allen wrench set, US and Metric
- Adjustable wrench – 24-inch
- Monkey wrenches – 15-inch and 18-inch
- Wire strippers, wire cutters and crimpers
- Screwdriver set, standard and electronic (small size), phillips and flat blade
- Diagonal cutting pliers, 8-inch
- Deep impact gun, 3/4-inch drive, 1 1/4-inch deep-impact socket
- A set of 3/4-inch drive sockets, including 1 5/8-inch
- A set of 1/2-inch drive sockets that range from 3/8-inch to 1-1/4-inch
- Drill set, cordless, with drill bit set 1/16-inch to 1/2-inch reduced shank
- Thread restoring tool and tap set
- Hacksaw
- Utiity knife
- Sledge hammer, 3-pound
- Tape measure, 36-inch
- Punch/chisel set
- Vice grip or bench vise, capacity to hold 5-inch
- Measuring level, liquid, 2-inch
- Shovel
- Circuit multimeter (with case), digital or analog, with electrical tester and amp probe
- Chain with hook ends
- Strap wrench vice grip
- Zerk fitting, 1/8-inch (pkg 10)
- Cable cutter
- Tool box, side mount
- Tool box, pack rat

Computer Equipment

- Laptop computer, equipped with Microsoft-equivalent Office software
- Ladder logic software (current installed versions)
- Service Tech CD (current version)
- COM cable

DynaPump Equipment

- Counterweight fill hose (P/N DP00315)
- Coupler alignment tool (No DP P/N)
- Cover plate, 2-inch hose (P/N 200-2SAE108)
- Cable removal tool (P/N D00166)
- V-block dolly, 1 each
- Base assembly supports, 2 each
- Counterweight storage stand, 4 each

Special Equipment

- Air compressor multiplier, 5 to 1 ratio
- Open capstan winch, rated at 800 pound pulling capacity
- Wire cable puller for 9/16-inch cable, rated at 500 lbs pull force
- Braided rope, 250 feet of 1/2-inch poly Dacron or polyester
- Forklift or mobile crane rated at 21,000 lbs lifting capacity
- Stationary crane with two trucks, each rated at a minimum lifting capacity of 7,000 lbs. The minimum crane runway dimensions should be 10 x 40 feet with a lifting height capability of at least 8 feet.
- Air compressor rated at 50 cfm @120 psi. The compressor must have a dryer installed so that there is no water in the delivered compressed air.
- Electric-powered portable grinding tool
- Ratchet chain hoist, rated at 3000-pounds
- Hydraulic jack, bottle, 12-ton
- Locks, keyed alike (order qty 4 min)

First Aid Equipment

- First aid kit
- H_2S Monitor for toxicity
- Fire extinguisher, ABC-type

Safety Equipment

- Harness, climbing (front D-ring)
- Lanyard, rope positioning, and tag line
- Tags, lock-out, vinyl
- Hasps, safety lockout
- Glasses, safety Z-28 type
- Gloves, protective leather
- Boots, steel-toe
- Hat, construction, hard plastic
- Ear plugs

NOTE: OSHA Safety training must be up-to-date and cover the following:

- *Pass port safety training*
- *H_2S*
- *Haz Com*
- *Respiratory protection*
- *First-aid/CPR*

Hydraulic Oil Specifications

Table 1. Hydraulic Oil Specifications

Characteristic	Texaco Rando HDZ 32	Mobil DTE 13M	Shell Tellus T32	Chevron Rykon 32
Oxidation Stability	HIGH	VERY GOOD	VERY GOOD	HIGH
Corrosion Protection	VERY GOOD	VERY GOOD	GOOD	VERY GOOD
Viscosity Index	HIGH	HIGH	VERY HIGH	HIGH
Antiwear Properties	VERY GOOD	VERY GOOD	GOOD	VERY GOOD
Anti-Foaming Additive(s)	YES	YES	YES	YES
Water Separation	FAST	GOOD	GOOD	FAST
Industry Specifications				
Vickers I-286-S	YES	YES	NO	YES
Vickers M-2950-S	YES	YES	NO	YES
Vickers 35VQ-25	YES	NO	NO	YES
Racine Model S	YES	NO	NO	YES
Cincinnati Machine P-68, P-69, P-70	YES	NO	NO	YES
Denison HF-0, HF-2	YES	NO	NO	YES
FZG Gear Test, DIN 51534 - Fail Stage	NO	11	NO	NO
FLUID DATA				
ISO Viscosity Grade	32	32	32	32
Kinematic Viscosity, cSt@40°C	30.4	32.0	32.4	32.0
Kinematic Viscosity, cSt@100°C	6.1	6.1	6.4	6.3
Viscosity Index	153	141	155	153
Flash Point, °C(°F)	220(428)	210(410)	160(320)	220(428)
Pour Point, °C(°F)	-50(-58)	-45(-49)	-45(-49)	-50(-58)

Section 4. Unpacking and Pump Unit Preassembly

This section discusses unpacking, and preassembly requirements (if required) after shipment.

> ⚠ **NOTE:**
>
> ***If the unit is shipped within North America, preassembly has likely been completed. The operator can skip Section 4: Unpacking and Pumping Unit Preassembly and proceed to Section 5: Installation, then continue with each process until commissioning of the unit has been completed.***

Shipment Types

Dynapump Pumping systems may be shipped in two ways according to location:

- **Domestic (North America)** - Arrives by flatbed truck, pump units are preassembled and ready for installation
- **International** – Arrives packaged in a shipping container, and pump units must be assembled in accordance with this manual.

When the shipping container arrives, verify that the contents match the shipping documents. Carefully unpack the container using either a crane or a forklift rated for 8,000 pounds. Remove the smaller parts and packages first, followed by the large structural base, counterweights units, hydraulic cylinder, and the Power Unit. Each shipping container may contain parts or assemblies for more than one pump.

Pumping Unit Final Assembly

> **NOTE:**
>
> ***Use an overhead crane (rated at 21,000 lbs) when moving the completed assembly to prevent damage to either nylon pulleys or hydraulic cylinder.***

Complete final assembly in accordance with the following steps:

1. Install the transducer into the cylinder support using two 5/16-inch screws (see Figure 3).

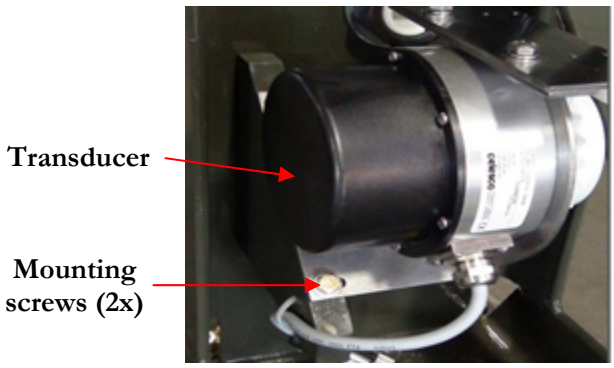


Figure 3. Installing Celesco Transducer Assembly

2. While the cylinder is supended, align the cylinder assembly to the base and counterweight structure by positioning the cylinder bolt holes with the holes in the base (see Figure 4).

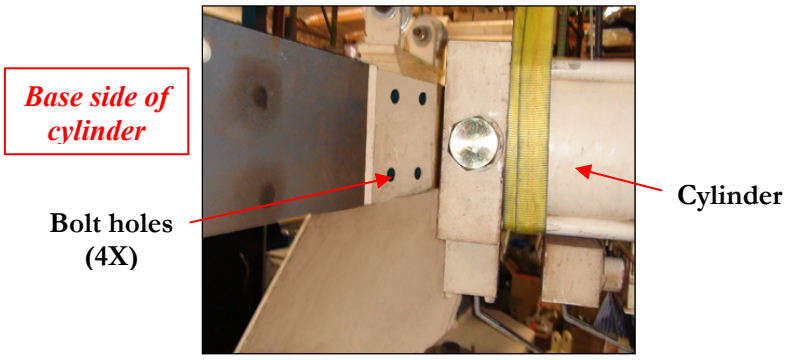


Figure 4. Aligning the Cylinder (Base side shown)

3. Secure the cylinder to the base structure using four 1-1/4 x 3-inch bolts and lock washers. Use anti-seize compound on the bolt thread (see Figure 5).

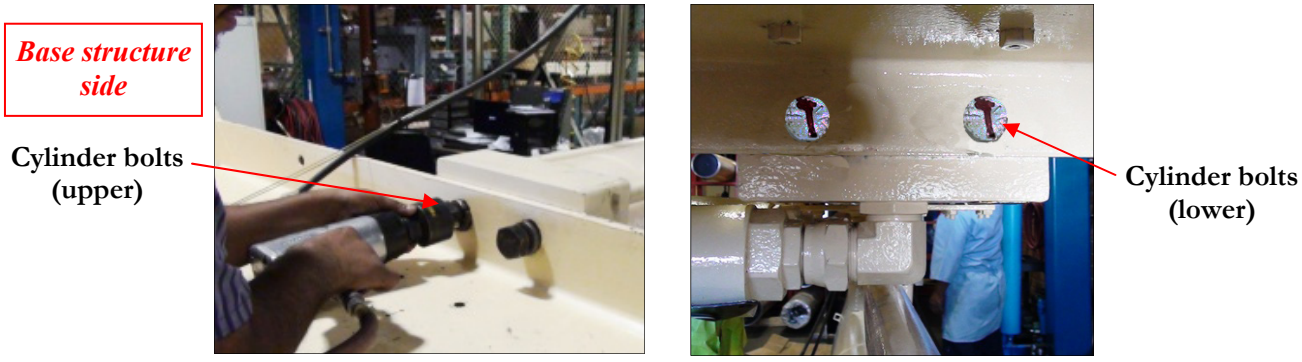


Figure 5. Securing the Cylinder (Base Side)

4. Secure the pulley side of the cylinder using two 1-inch x 2-1/2- inch bolts, four flat washers, two 1-inch lock washers and nuts (see Figure 6).

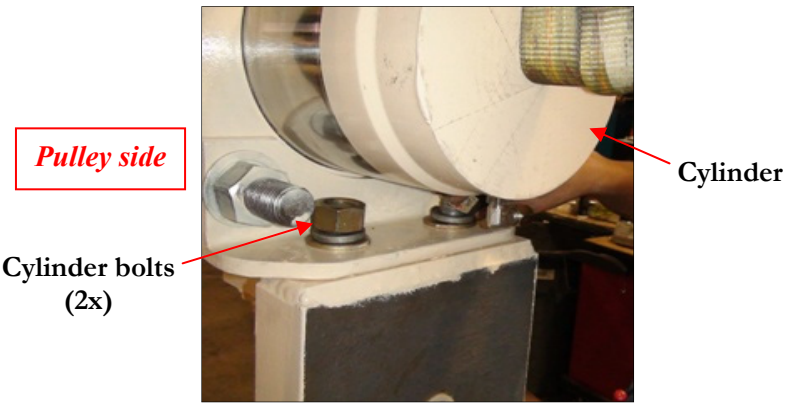


Figure 6. Securing the Cylinder (Pulley Side)

5. Install a rubber wiper with inserted o-ring onto the cylinder (see Figure 7).

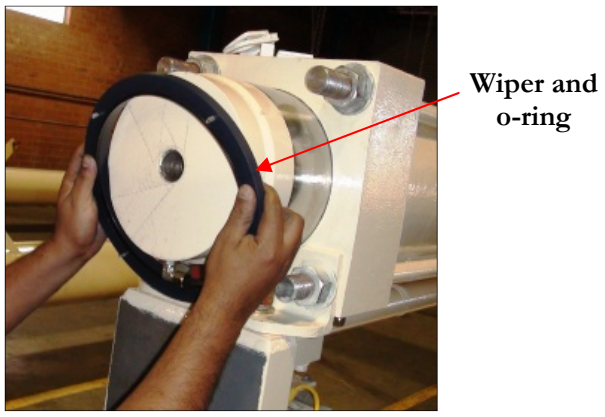


Figure 7. Installing the Wiper Ring

6. Loosen cylinder attach bolts, and install wiper tabs over the bolts to secure the wiper ring to the cylinder shaft, then retighten attach bolts (see Figure 8).

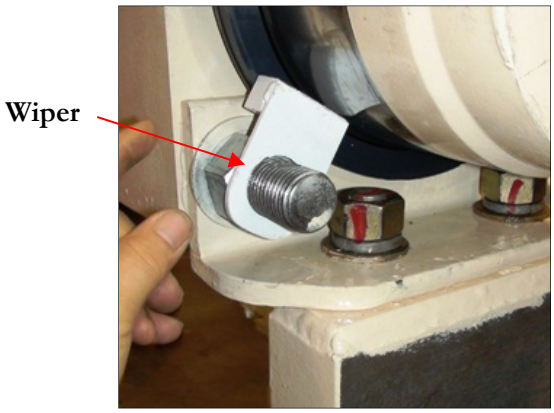


Figure 8. Installing Wiper Tabs

7. Mount four cable sheaves to the tension plate. Secure with two 1-1/8 hex cap screws 6-inches long, and four 1-1/8-inch flat washers, and two lock washers and nuts. Install four 3/8-inch roll pins into the plate with a hammer (see Figure 9).

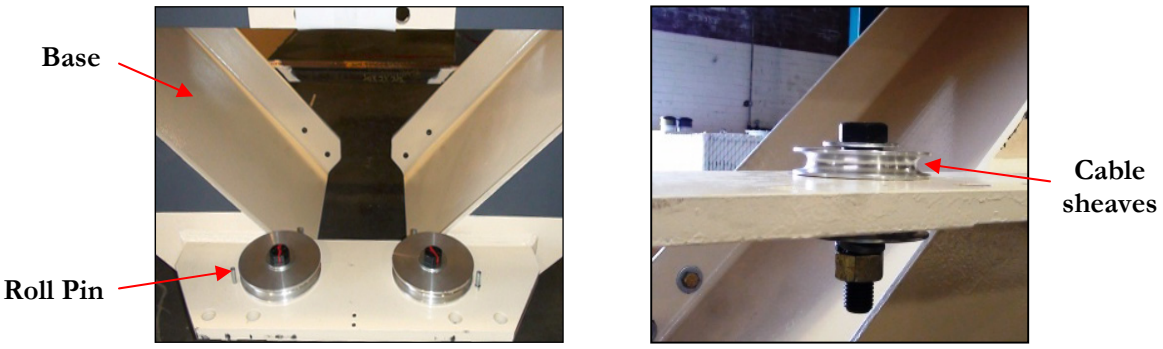


Figure 9. Installing Cable Sheaves

8. Mount a PVC pipe below the downpipe, and secure the upper and lower counterbraces segments, attaching the two pieces together with bolts (see Figure 10).

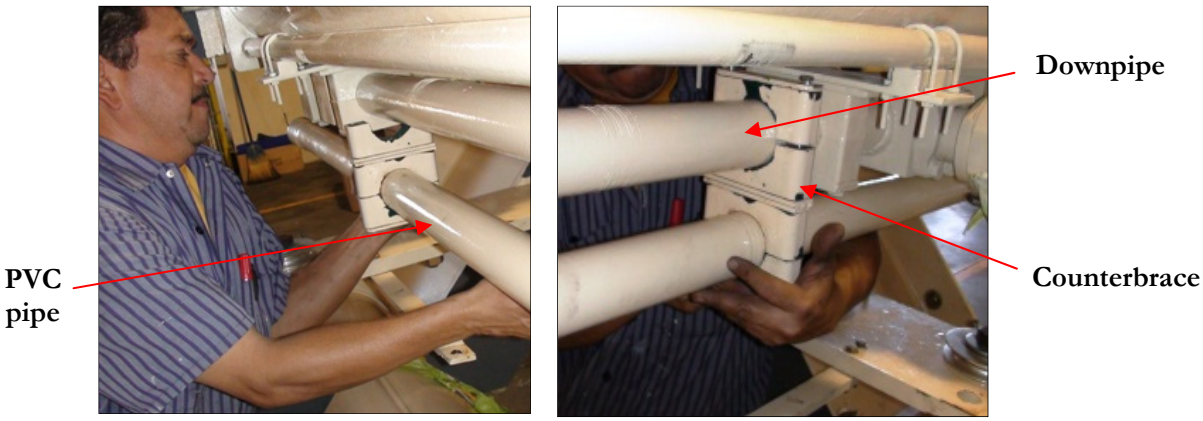


Figure 10. PVC and Downpipe Connection

9. Hoist the pulley assembly using a metal support rod through a pair of 2-inch holes located near the top of the pulley support (see Figure 11).

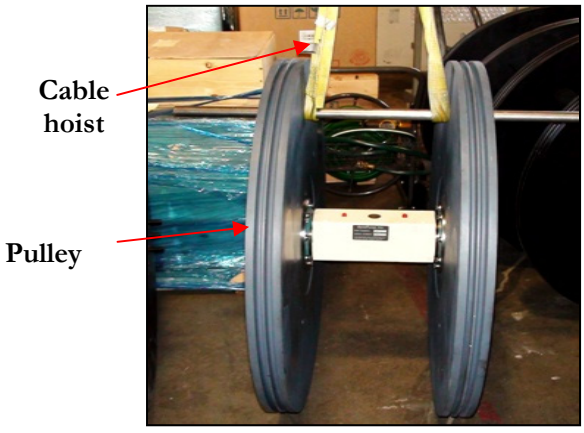


Figure 11. Hoisting Pulley Assembly

10. Attach the L-shaped bracket to the pulley support using 7/16-inch screws (see Figure 12).

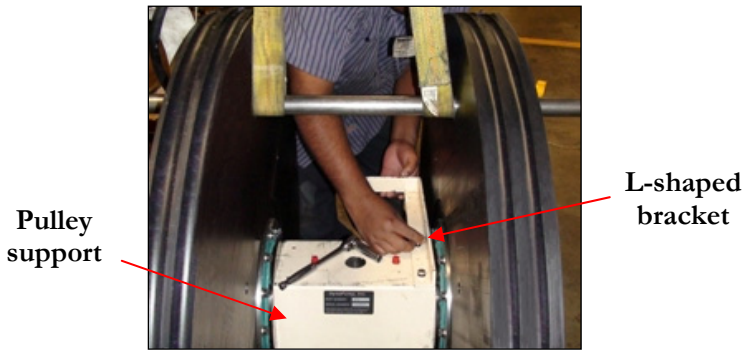


Figure 12. Attaching L-bracket

11. Align the hole through the pulley support with the threaded hole in the cylinder. Secure pulley assembly using the existing cylinder 1 1/2-inch bolt and lock washer. Tighten bolt with the impact wrench (see Figure 13).

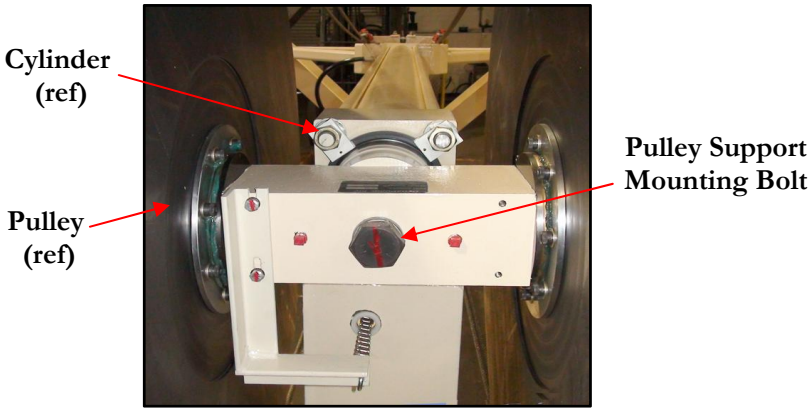


Figure 13. Pulley Installation in Cylinder

12. Feed a metal wire attached to the chain on the base side, and slowly feed the attached chain links through the PVC pipe (see Figure 14).

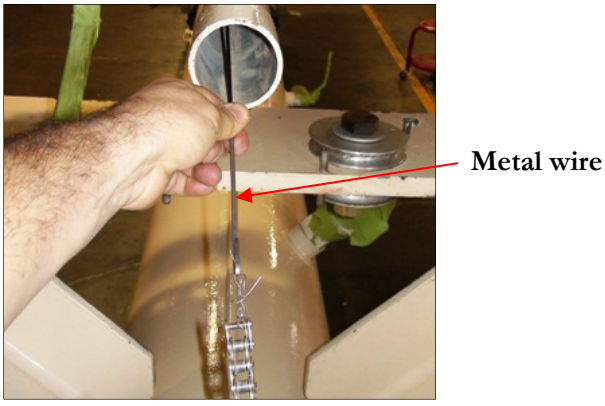


Figure 14. Inserting the Chain through PVC Pipe

13. Loosen the transducer mounting bracket to feed the chain over the sprockets of the transducer. When the chain meshes with the sprockets, reattach bracket (see Figure 15).

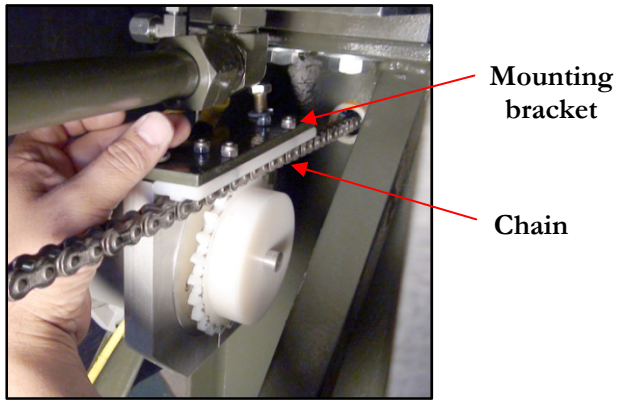


Figure 15. Passing the Chain through Transducer Sprockets

14. Stretch the chain through the cylinder bracket and around the L-shaped bracket on the other side to install the snap spring into bracket (see Figure 16).

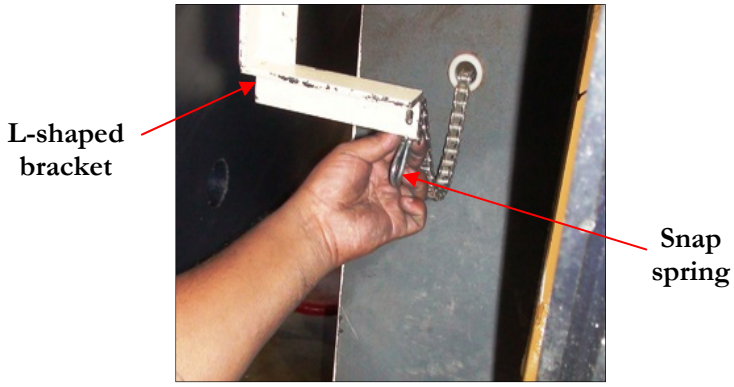


Figure 16. Securing the Snap Spring

15. Terminate the base side of the chain by attaching a counterweight (see Figure 17).

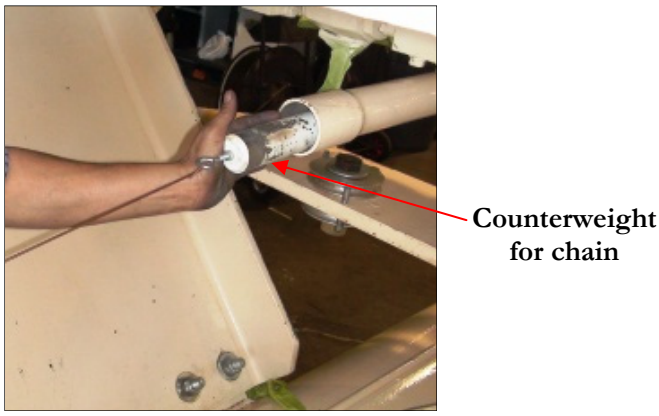


Figure 17. Terminating Chain with Counterweight

16. On the other (base) end of the down pipe, secure the counterweight with a bent wire and attach to the back of the pipe (see Figure 18).

Figure 18. Securing the Counterweight

17. Install the position sensor and bracket assembly to the tension bar (see Figure 19).

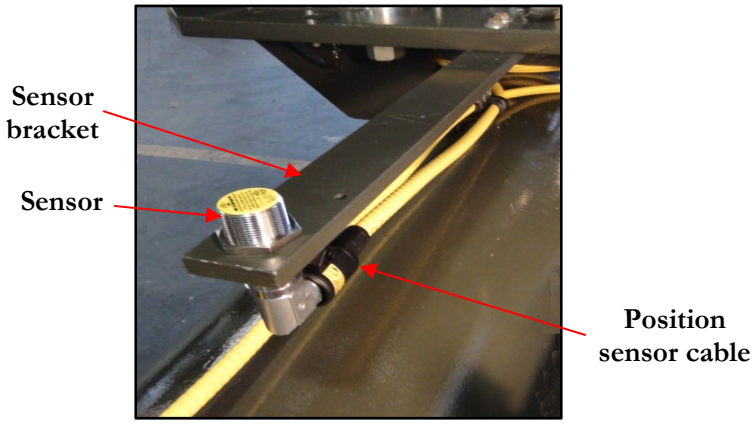


Figure 19. Position Sensor and Sensor Bracket

18. Electronically connect the transducer cable (see Figure 20).

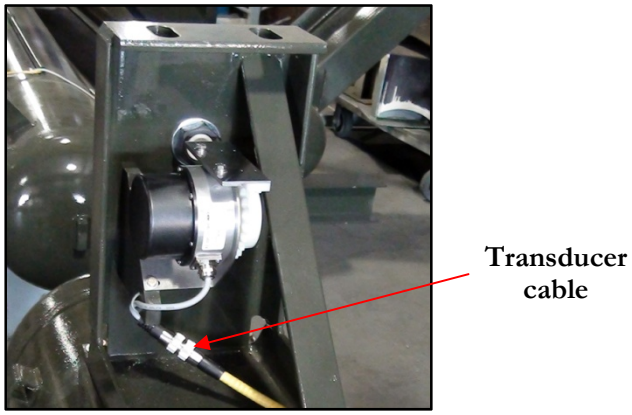


Figure 20. Transducer Wiring

19. Note the attachment points on the Power Unit for the transducer and position sensor. This connection will be performed during final installation (See Figure 21).

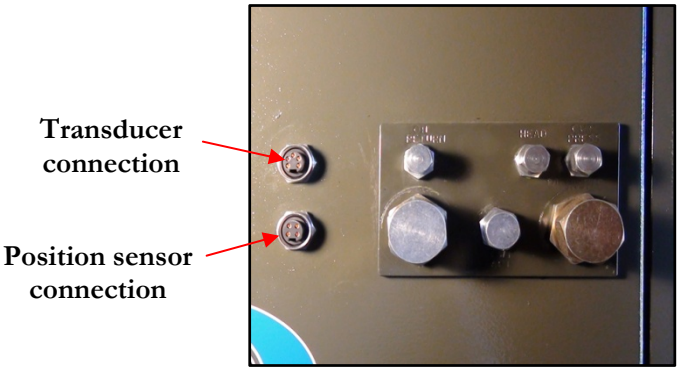


Figure 21. Cable Attachment Location on Power Unit

20. Begin installation of the pulley tension rope by stringing the 7/16-inch cable from the roll through the base. The pumping unit requirement is for 140 feet of cable (70 ft per pulley). See Figure 22.

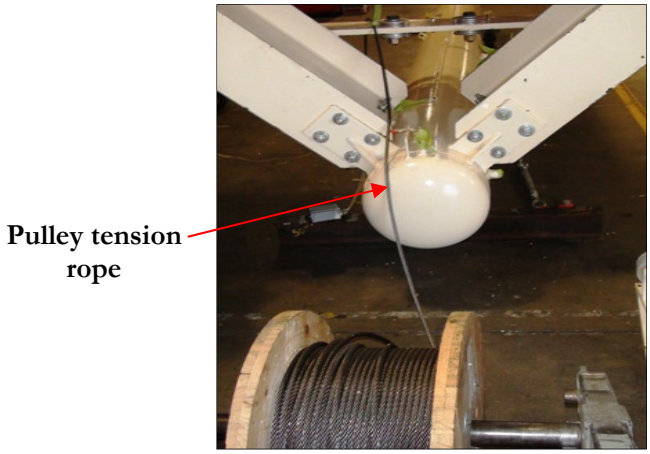


Figure 22. Cable Installation

21. Route the cable through the innermost groove of the first pulley (see Figure 23).

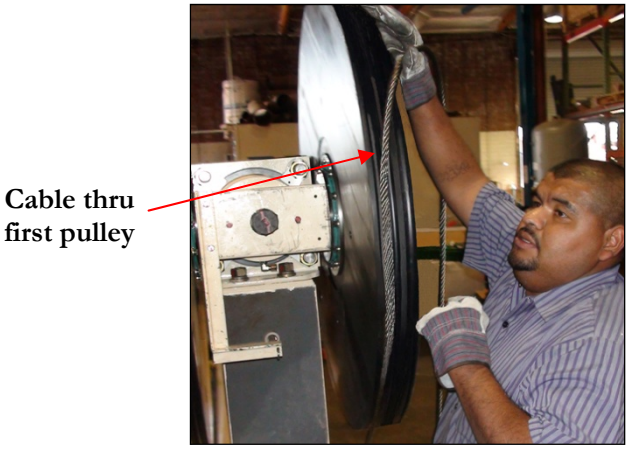


Figure 23. Routing the Pulley

22. Using Figure 24 as a general guide for cable routing.

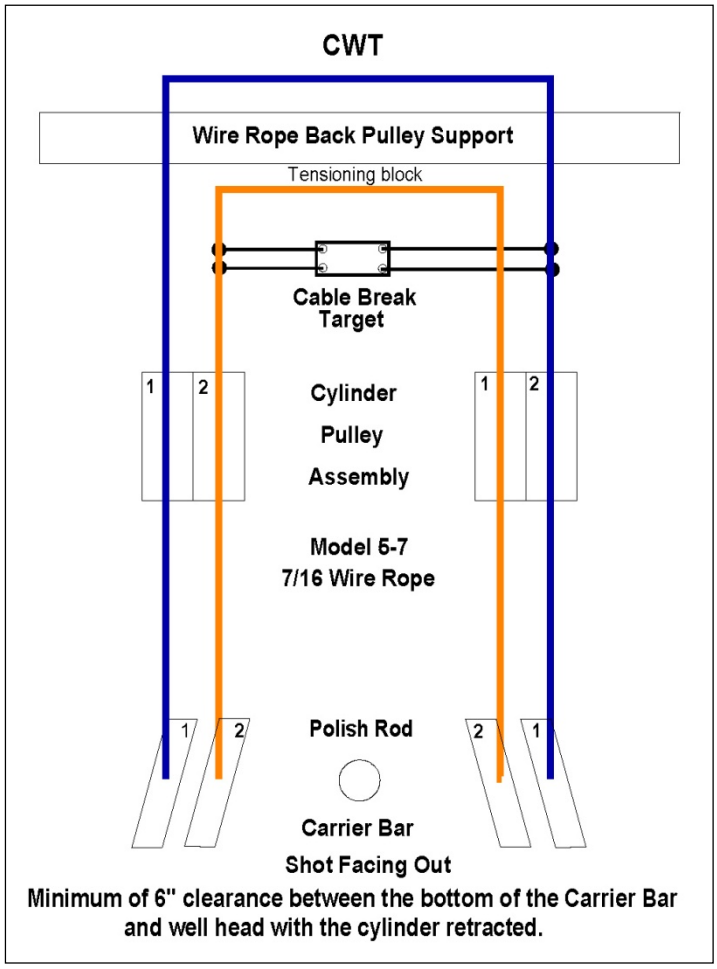


Figure 24. Cable Routing Diagram

23. Route the cable under the sheave of the first pulley to the underside of the sheave to the on the other sheave on the opposite side of the cylinder (see Figure 25).

Figure 25. Routing Cable under Sheave

24. Route cable around the second pulley, and continue the process of cable routing until both pulleys are wired (see Figure 26).

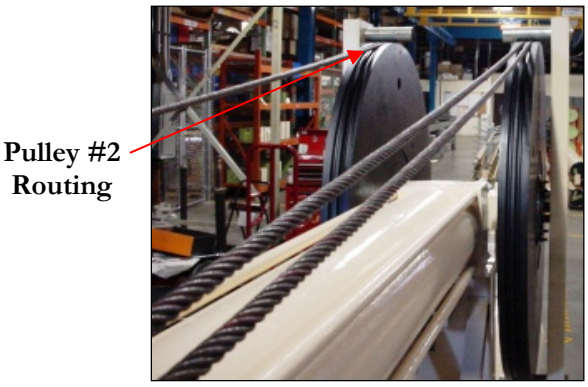


Figure 26. Finalized Pulley Routing

25. Tie off the cables using the wedge sockets and cable clamps to secure the cable to the cable weldment (see Figure 27).

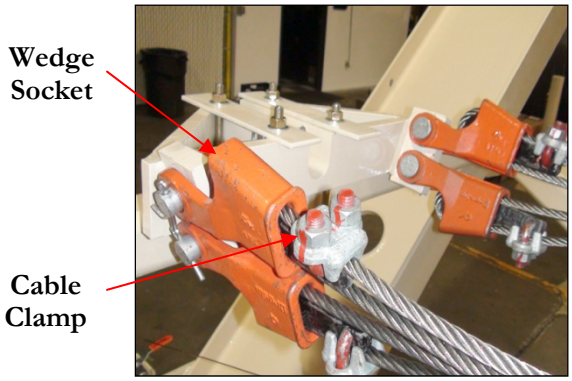


Figure 27. Installing Wedge Sockets and Cable Clamps

26. Install leveling feet to the base of unit and apply anti-seize grease (see Figure 28).

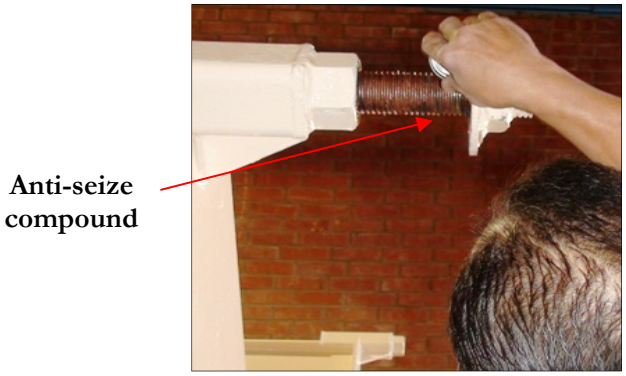


Figure 28. Leveling Feet on Base

27. An example of an asembled unit appears as follows in the field (see Figure 29).

Figure 29. Assembled Field Unit with Stowed Carrier Bar

28. Remove the 3/8-inch cap on the charge valve assembly and connect the charge port to an air pressure source capable of filling the pipe to 1000 psi (see Figure 30).

> **⚠ WARNING:**
>
> ***Cylinder gas pressure can be manually released in a non-operating state by opening the bleeder valve on top of the actuator. Opening this valve slowly will release any load the ram may be carrying and enable the ram to return safely to its full down position. The valve should be open only while running under normal conditions to prevent the ram from accelerating through to its fully extended position when loads are disconnected.***

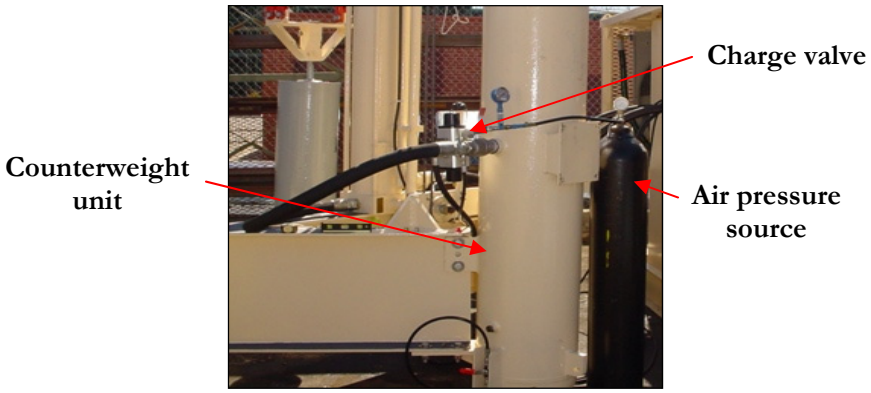


Figure 30. Pressurizing Counterweight Charge Valve

29. Repressurize the counterweight unit to the pressure established based on well loading conditions. Depending on variances in pump size and power unit requirements, units may need to add or bleed off some pressure. If shipped domestically, units are initially pressurized to 600 psi.

30. Allow the pressure in the counterweight to equalize with the compressor pressure prior to starting the pressure amplification phase.

31. Monitor the 3/8-inch and 1 1/2-inch fitting connections for leaks during the filling process by applying soapy water and looking for bubbles. Verify that the ball valves are open when monitoring for leaks to test the downstream fittings up to the cap.

32. Grind off the brace on the base using a portable electric grinding tool (see Figure 31).

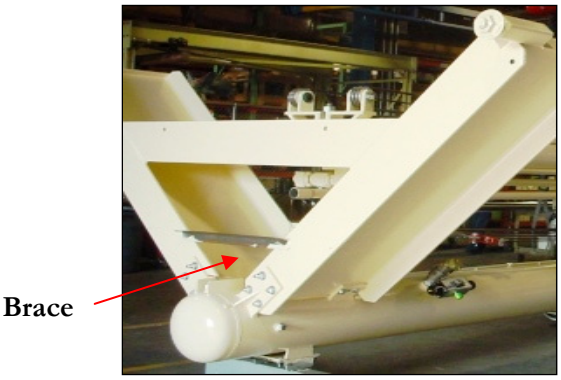


Figure 31. Brace Removal on Base Unit

33. Once the pipe is charged, close the charge ball valve and terminate charging process.

34. Reinstall the 3/8-inch cap to the charge valve assembly.

35. The assembly may now be moved by placing the V-block dolly under the pulley end of the counterweight and the using a forklift to tow the other end by attaching to the base cross member using the holes provided.

Power Unit

1. Load the hydraulic oil tank with 28 gallons for 25HP or 40 HP power unit systems of oil.
2. Load the hydraulic oil tank with 10 gallons for systems with 15 or 25 HP power units of oil. See Figure 32 for tank location.

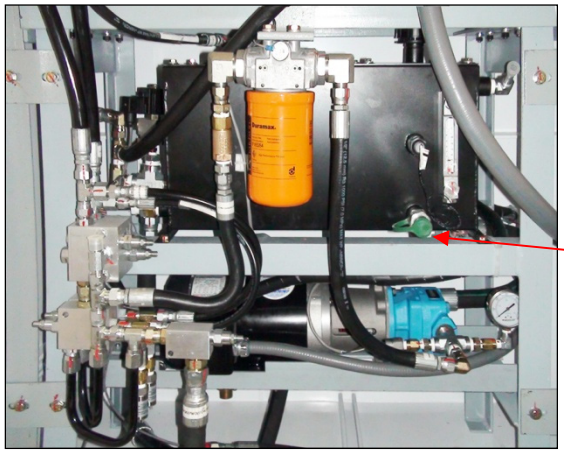


Figure 32. Hydraulic Tank Location

Transportation of Assemblies to the Site

General guidelines are as follows:

> ⚠ **NOTE:**
>
> ***The ship kit box can be stored separately by the driver in a truck location where it doesn't get damaged.***

- Load the assembled pumping unit on the trailer.
- Place blocks on the trailer for the pumping unit to rest on.
- Securely tie ropes or other fastening materials around the pipe and over the base. Make sure the ties are not binding on the cylinder.
- Load the ladders and the skid system.
- Load the power unit on the front of the trailer. The driver can tie down the power unit over the top of the frame.

Section 5. Installation

This section discusses final assembly and installation of pumping and power unit assemblies.

⚠ Safety Precautions

The following are ***safety precautions***:

- When hoisting or moving components or assemblies, always use a crane or forklift rated for the load being lifted or supported.
- Personal safety equipment should be worn (e.g. hard hat, steel-toe shoes, boots, etc.)
- Ensure that chains and cable slings used in the erection of the system have a load test certification tag suitable for the load being lifted.

Pumping Unit

The Pumping Unit will be delivered to the well site on a flat bed truck.

1. Unload the pumping unit from the flat bead truck with a 3-point sling, and place horizontally on a flat surface.
2. Erect the pumping unit with a crane capable of lifting 10,000 lbs. The crane should have a nominal reach capable of maintaining a minimum hook height of approximately 20 feet. (see Figure 33).

Figure 33. Lifting the Pumping Unit

3. Retrieve the two auto lubbers, P/N 155-1, from the installation kit to maintain a constant flow of grease to the pulley support bearings. The process keeps contamination from migrating into bearings during normal operation.
4. Install the auto lubbers in the grease ports on the top of the pulley support mounted on the very top of the cylinder (between the two nylon pulleys).
5. Activate the auto lubbers by turning the switch to the "**On"** position. Verify activation by confirming that the indicator light on each lubber is functioning.

6. Verify through the site glass (see Figure 34) that hydraulic oil is present in the counterweight unit. The oil will have a clear to yellow appearance and the metallic surface will have a sheen. If the counterweight appears empty, refill the hydraulic tank (see "Power Unit".

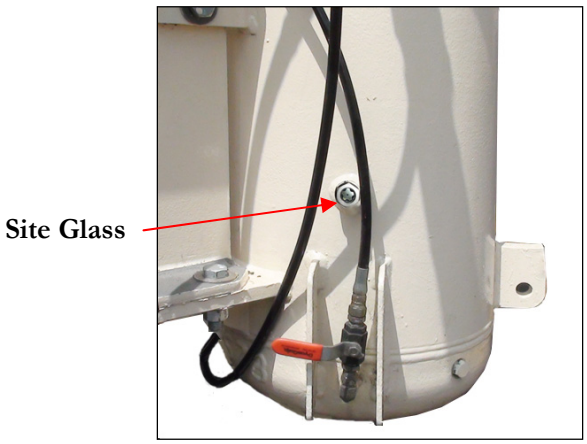


Figure 34. Site Glass

Pre-installation Well Head Verification

Several checks must be made after the construction has been finalized by the bottom hole pump installer and before the DynaPump unit is positioned in place by service personnel. These verifications ensure that the maximum surface and downhole stroke for the pumping unit is available, and that no damage will occur to the cylinder, stuffing box or bottom hole pump.

> **NOTE:**
>
> ***Review the down hole detail from the rig contractor to obtain the polish rod length and bottom hole pump stroke capacity. This important data will be used to calculate predicted loads.***

This is what a typical well looks like after it has been installed (see Figure 35).

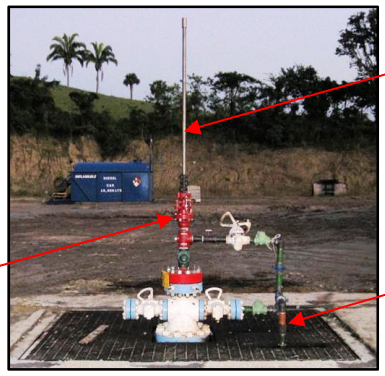

NOTE:
Polished rod is in place and the rod string is spaced off the bottom, supported by the rod clamp, which is resting on a stuffing box.
Rod clamp
Flow lines

Figure 35. Typical Well Appearance

Bottom hole design requirements are as follows:

1. Well head height should NOT be higher than the height of the bottom of the cylinder if the pumping unit would have been on piers. This distance, shown as distance "A" from the stuffing box to the top of the piers, is approximately 50 inches. If it appears that the height of the pumping unit is not tall enough, more aggregate should be poured to increase the height. See Figure 36.

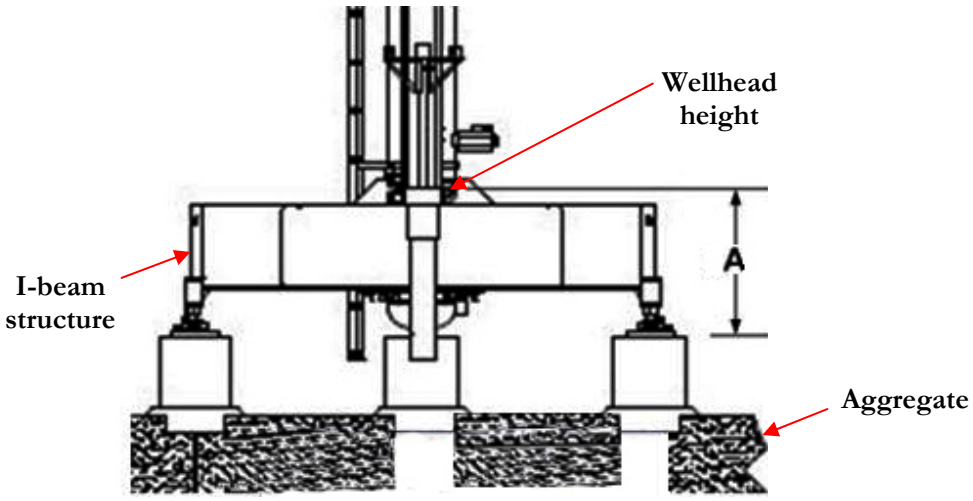


Figure 36. Well Design Requirements

2. The polished rod must be long enough to allow full travel of the pumping unit without having the coupler to the first sucker rod come in contact with the stuffing box. This distance should also be long enough to extend above the stuffing box for attachment of the carrier bar, polish rod clamp, plus the clearance between the top of the stuffing box and the bottom of the carrier bar (see Figure 37).

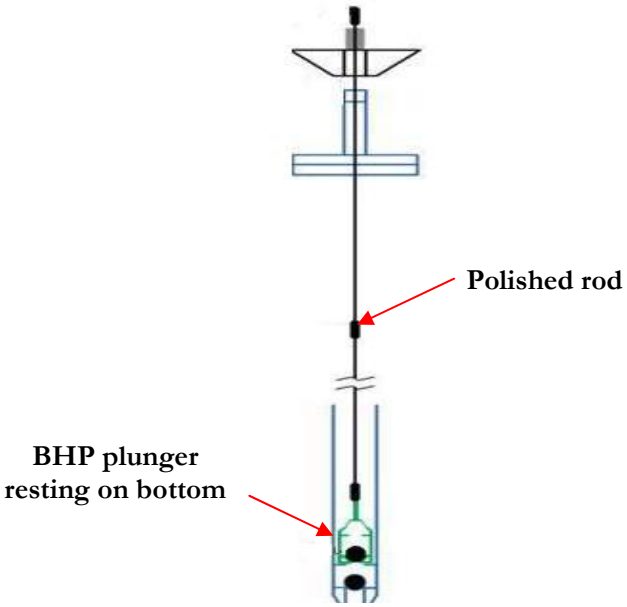


Figure 37. BHP Plunger Spacing

3. Distance between the pulley assembly and carrier bar must be longer than the desired stroke length (see Figure 38).

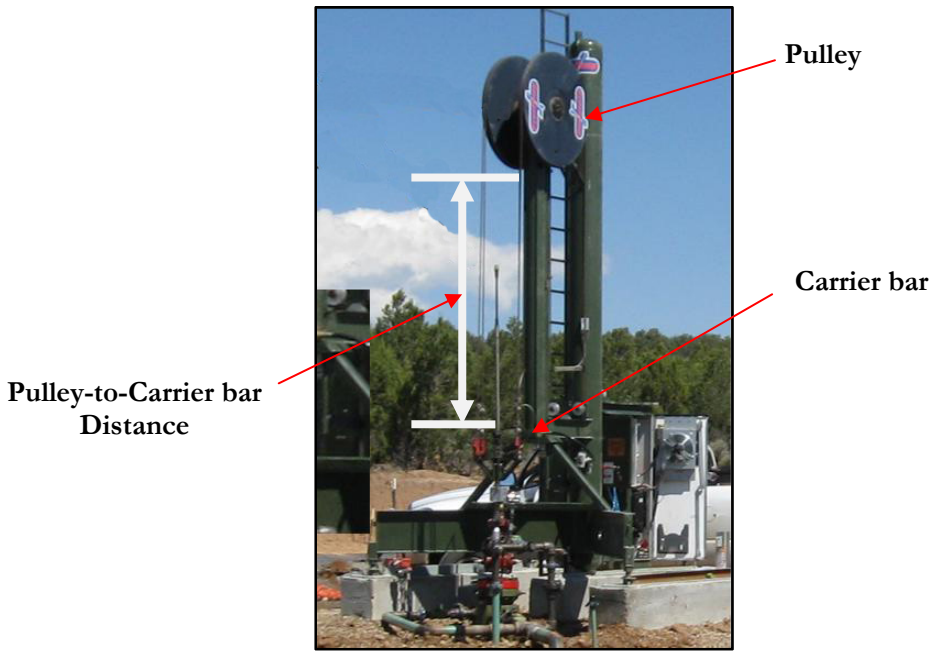


Figure 38. Pulley to Carrier Bar Distance

4. The relationship between the barrel and plunger length must exceed the surface stroke capacity. For example, a Model 5 has a 168" surface stroke. The bottom hole pump (BHP) barrel is 240" long. The BHP plunger is 48". The effective stroke length is 192". Therefore, the BHP stroke capacity is 24" longer than the surface stroke capacity. See Figure 39.

   For a model 5 pumping unit, the following specifications exist:

Specified stroke length	Plunger travel for stroke length (2:1 ratio)	Available plunger travel (inches)	Plunger margin at full stroke (inches)
168	84	90.5	6.5

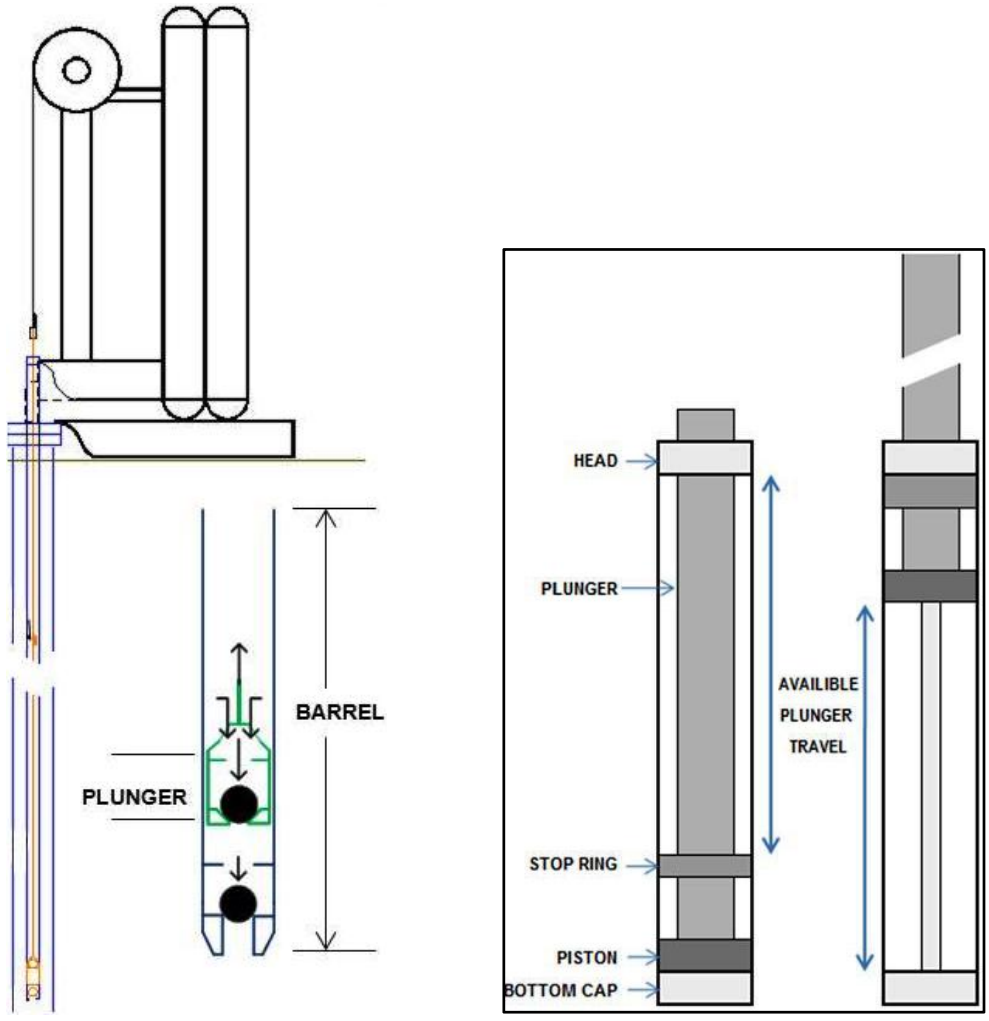


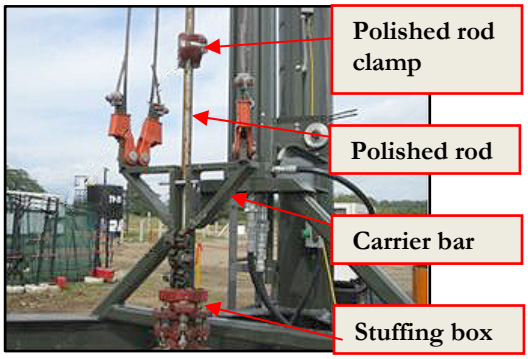
Figure 39. Barrel to Plunger Length Distance

Stacking out the Rod String to Verify and Position BHP Plunger off the Bottom

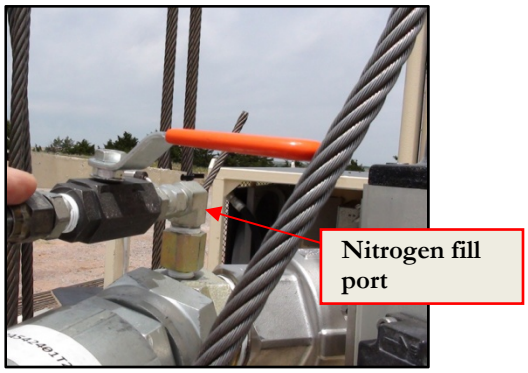
NOTE: This procedure requires the DynaPump system to be completely installed, hoses connected between the Power and Pumping Unit, the cylinder bled of any air, carrier bar position properly adjusted in relation to the well head and the cylinder ball valves open.

Perform these steps:

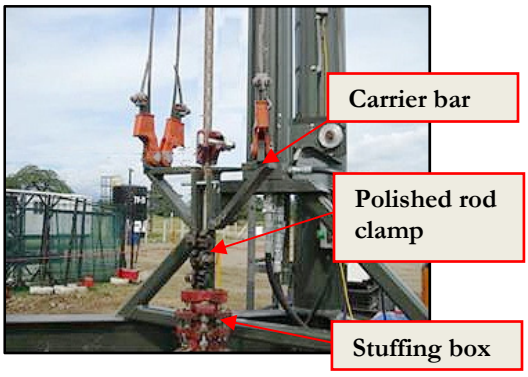
1. Attach the polished rod clamp close to the top of the polished rod to assure the string will stack out before the carrier bar comes into contact with the stuffing box.
2. Connect a nitrogen bottle and fill hose to the fill port adjacent to the counterbalance actuator valve.
3. Slowly add nitrogen. The carrier bar will slowly slide up the polished rod and eventually lift the rod string and lower clamp off the stuffing box.
4. Loosen, but don't remove, the clamp that was supporting the rod string on the stuffing box.
5. Make sure the fill valve on the pumping unit is closed and the valve on the nitrogen bottle is closed, then remove the hose.



6. Slowly open fill/drain port. As nitrogen bleeds off, the carrier bar slowly moves down.
7. Continue bleeding pressure until the carrier bar moves slighly down below the clamp.
8. At this point, the rod string is stacked out, meaning the BHP plunger is resting at the bottom of the BHP barrel.
9. Tighten the clamp that is resting on the stuffing box just enough in,so it moves with the rod string as it is lifted up.



10. Reconnect the nitrogen bottle and fill hose to the fill port.
11. Slowly add nitrogen, and continue to add as the rod string moves upward.
12. Note the space being created between the stuffing box and the bottom of the clamp.
13. Continue to add nitrogen to move the rod string up until the desired measurement is achieved., typically, one to two feet , depending on depth and anticipated rod stretch and dynamics.
14. Loosen the clamp below the carrier bar. Slide it down until it is resting on the stuffing box and then tighten to sustain the rod load.
15. Make sure the fill valve on the pumping unit is closed and the valve on the nitrogen bottle is closed. Then remove the hose.



16. Slowly open the fill/drain port. As the nitrogen bleeds off, the carrier bar will slowly move down.
17. Continue to bleed off the pressure until the rod string is supported by the clamp on the stuffing box.
18. Continue to bleed off the nitrogen until the cylinder is fully retracted and the carrier bar is hanging, supported by the wire rope.
19. Loosen the clamp above the carrier bar. Slide it down until it is resting on the stuffing box and then tighten to sustain the load.
20. Reconnect the nitrogen bottle and fill hose to the fill port.
21. Slowly add nitrogen, and continue to add as the rod string moves up until the load is supported by the carrier bar and top clamp.
22. Remove the clamp below the carrier bar.
23. At this point, the cylinder and rod string are spaced properly.

Typical Problems Related to Improper Installation

Shown below are two improper installation scenarios caused by the pumping unit (bottom cap of cylinder) being positioned lower than the well head. In each case, the pumping unit loses stroke length.

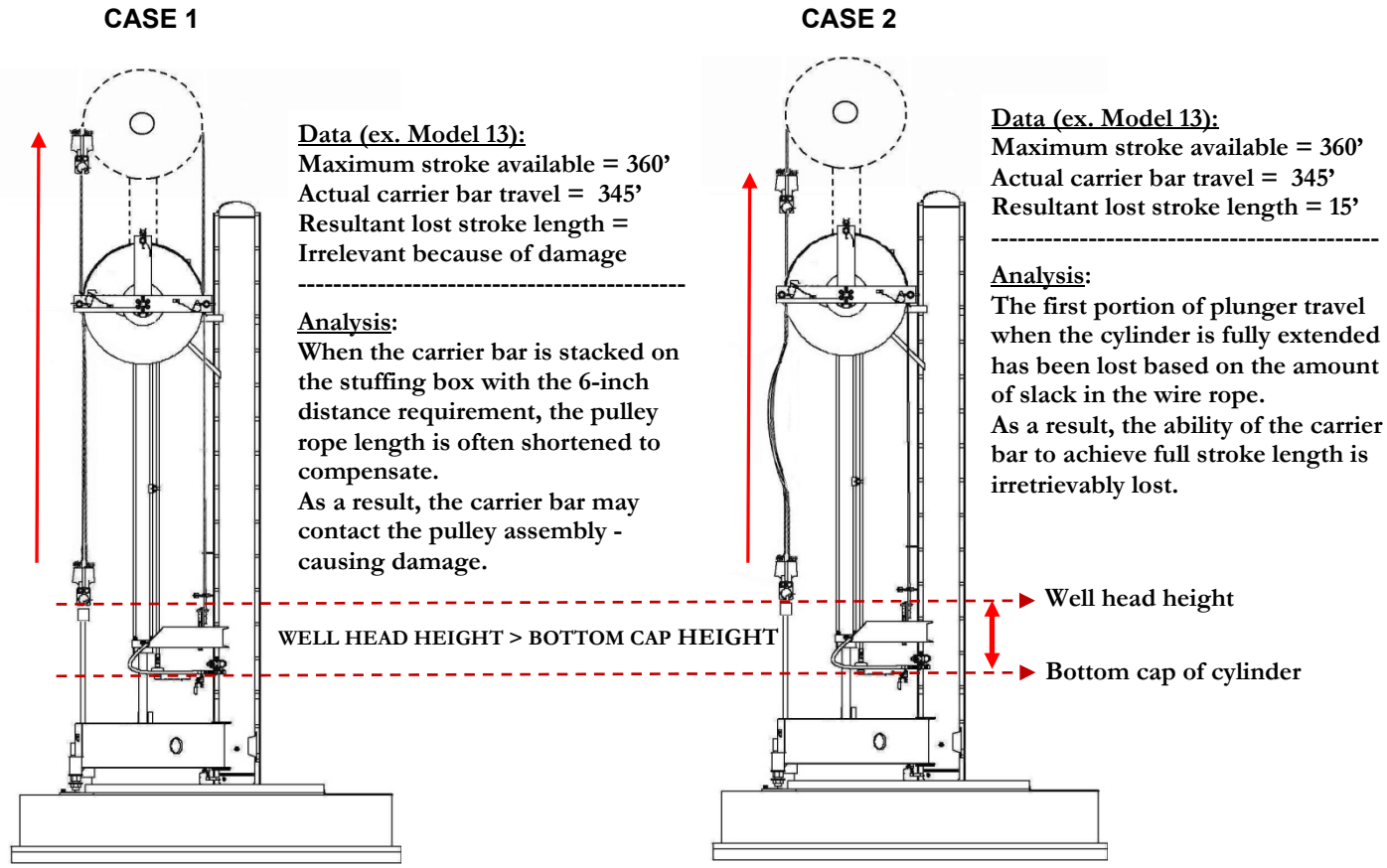

CASE 1
CASE 2
Data (ex. Model 13):
Maximum stroke available = 360'
Actual carrier bar travel = 345'
Resultant lost stroke length = Irrelevant because of damage
Analysis:
When the carrier bar is stacked on the stuffing box with the 6-inch distance requirement, the pulley rope length is often shortened to compensate.
As a result, the carrier bar may contact the pulley assembly - causing damage.
WELL HEAD HEIGHT > BOTTOM CAP HEIGHT
Data (ex. Model 13):
Maximum stroke available = 360'
Actual carrier bar travel = 345'
Resultant lost stroke length = 15'
Analysis:
The first portion of plunger travel when the cylinder is fully extended has been lost based on the amount of slack in the wire rope.
As a result, the ability of the carrier bar to achieve full stroke length is irretrievably lost.
Well head height
Bottom cap of cylinder
CASE 1: CARRIER BAR HITS PULLEY
CASE 2: LOOSE WIRE ROPE CAUSES LOSS OF STROKE

Figure 40. Improper Installation Scenarios

SOLUTIONS:

CASE 1 – Increase the aggegate (sand) level below the piers.

CASE 2 – Tighten loose wire cable so it is not hanging. Unfortunately, this reduces the stroke length.

Skid Unit Installation and Placement of the Pumping Unit

The skid system contains the rail framework on which the pumping unit rests and is mounted directly over the concrete piers (See Figure 41).

> **NOTE:**
>
> ***Installation of the skid plates provides for coarse alignment of the pump relative to the wellhead. If rig work still needs to be done, the pumping unit should be mounted to the back of the skids.***

When the skid system is installed, the pumping unit can slide forward on the rails and be positioned directly over the wellhead. If the pumping unit is undergoing maintenance, or before commissioning takes place, the unit is retracted to a safe postion at the rear end of the skid rails. There are stops on the front and rear end of the skid to prevent the pumping unit from sliding off the rails and piers. See Figure 41.

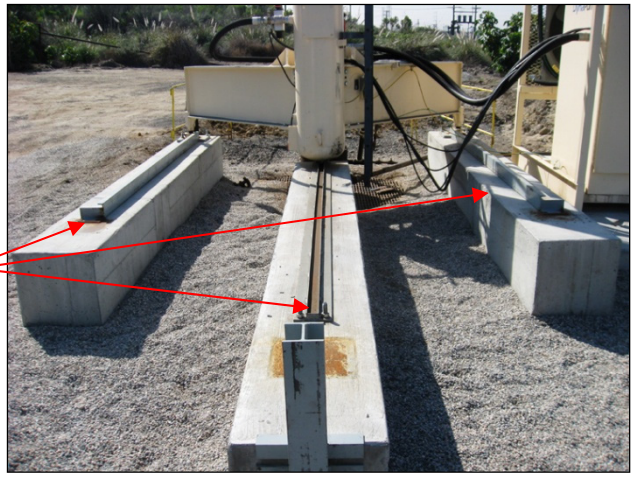


Figure 41. Skid System

Perform the following steps to install the skids:

> **NOTE:**
>
> ***Prior to placing the pump in position, be sure that the area is free and clear of any obstacles. Follow all standard oil field safety practices while completing the installation. Ensure the well is not pressurized to preclude a serious accident if the wellhead is accidentally bumped.***

1. Slowly erect the pump using the crane until the pump is fully suspended from the crane.
2. Use a 10-foot extension chain or sling to prevent the crane hook from hitting the counterweights as they come to vertical position. The crane and attachment clevis must be rated at 25-ton to provide a safety margin.
3. Align the pump over the skid mounting point so the pump is centered over the wellhead.

4. Support the V-frame base with two bottle jacks to lift the load off the outer skids, and then secure the center skid to the concrete pier.

NOTE: Steps 5 through 8 discuss cylinder verticality.

5. Measure the side-to side and front and back verticality of the pump using a 2-foot magnetic bubble level. Place the bubble level on the cylinder wall, and also on another location, such as a smooth vertical surface on the bottom cap. See Figure 42.

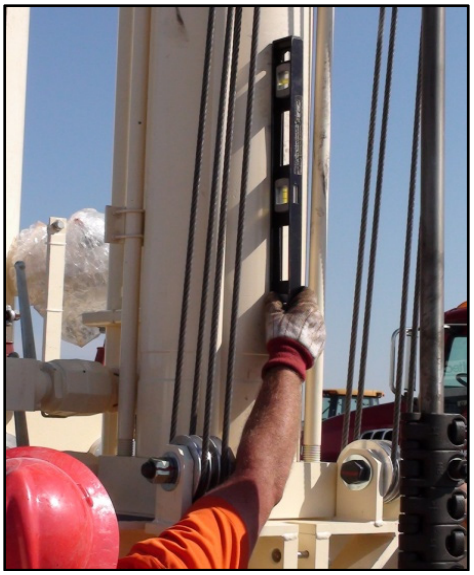


Figure 42. Cylinder Alignment: Verticality

6. If the cylinder is not vertical, rotate the adjustable feet on each base leg as required to bring the cylinder to the vertical position. See Figure 43.

Figure 43. Cylinder Alignment: Verticality Adjustment

7. Perform a side-to-side measurement from the center of the cylinder to see if the feet are equidistant. Alternately, verify that the polished rod is centered on the cylinder centerline. See Figure 44.

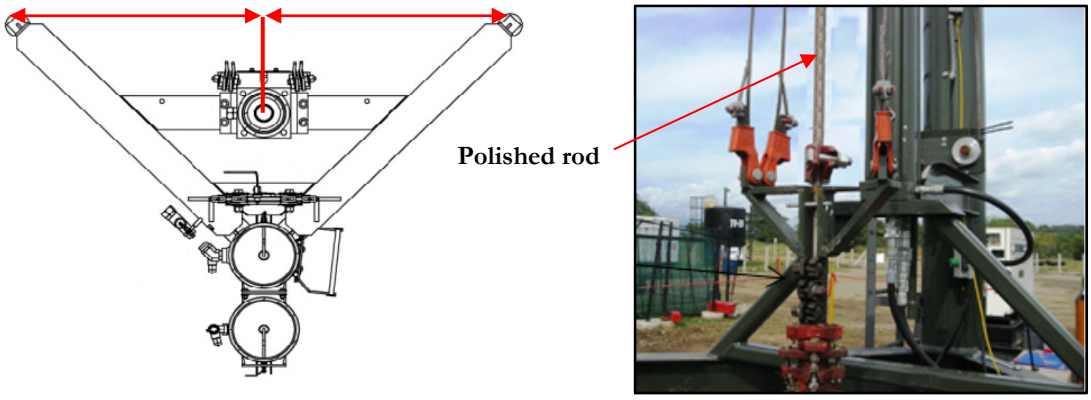


Figure 44. Cylinder Alignment: Side-to-Side (and Front-Back)

8. If the sides are not equidistant, use a chain to forcibly align the pumping unit. Alternately, a cheater bar may be applied on the skids to apply the proper torque for leverage. See Figure 45.

Figure 45. Cylinder Alignment: Side-to-Side (and Front-Back) Adjustment

9. Verify that the setback distance from the centerline of the polished rod to the front edge of the cylinder bottom cap is 17.5 ±.5 inches. This ensures that the cables will be in the same plane as the polished rod. If the distance is incorrect, move the pump fore or aft as required to establish this distance. See Figure 46.

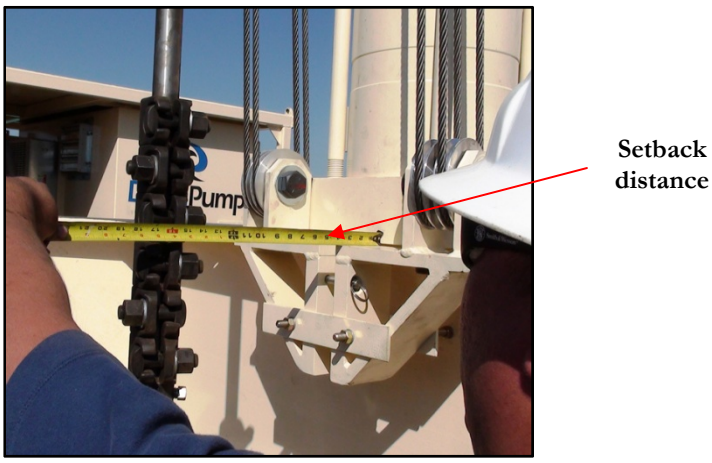


Figure 46. Cylinder Alignment: Setback Distance

10. Once the pumping unit is in position, perform a final align on the outer skids so that the extended feet from the pumping unit can slide easily into each outer skid.

11. When each adjustment foot is centered on the skid pad, and the capture washer just clears skid capture angle, install one bolt in front section. The feet should be screwed all the way into the base legs.

12. Adjust the rear sections of outer skids so they are parallel and accommodate full track back, and then bolt the outer skids in place.

13. Remove the bottle jacks from the base.

14. Install a safety chain on each leg of the base to the attach point on the side skid. Each chain consists of approx. 14 inches of 1/4-inch grade 40 steel chain, a jaw & jaw turnbuckle, and two each 3/8-inch anchor shackles, included in the Installation Kit.

The Pumping Unit is now ready to be mated to the Power Unit and attached to the wellhead.

Power Unit

Power Units are shipped fully assembled and require no special assembly prior to normal operation.

General Checks

The following checks should be performed prior to delivery:

- Visually check the assembly and touch up any paint areas that have been scuffed or chipped during transport. Verify there is no damage to any of the exterior components.
- Remove the motor mount covers and tighten the motor coupling setscrews. Visually verify that the motors are properly aligned. Reinstall the motor mount covers.
- Open the hydraulic cabinet and visually inspect for damage. Tighten all hose connections and fittings to make sure they are snug. Verify that the hydraulic oil level is near the top of the tank as shown on the glass scale. Close the cabinet and lock it.
- Open the electrical cabinet and visually inspect for damage. Tighten all wire terminal connections to make sure they are snug. Close the cabinet and lock it.

1. Using a crane, lift the Power Unit using straps or chains connected to the lifting hooks on the top of the unit. Maneuver the unit so it is positioned over the foundation pad with the cooling fan facing the rear of the pad. Verify installation dimensions are correct before removing the crane hook.

2. Ensure that the Power Unit C-channel bottom leg is flat on the concrete pad prior to tightening the bolts. If not, add shims, as required, near the boltholes to prevent the possibility of distorting the frame as the mounting bolts are tightened.

3. Connect 480 volt 3-phase power to the unit at the disconnect safety switch. The customer or their designated representative shall be responsible for this task to ensure that the connection conforms to local rules and regulations. Once connected, make sure that power is locked out until pump installation is complete.

4. Install a ground rod at least 6' long on the side of the Power Unit near the green ground strap to provide an earth ground to both the Pumping Unit and Power Unit.

Final Assembly

Perform final hose and pumping unit structural connections (see Figure 47).

Power Unit to Pumping Unit Connections

Refer to the following photos for connections between the Power Unit and the Pumping Unit.

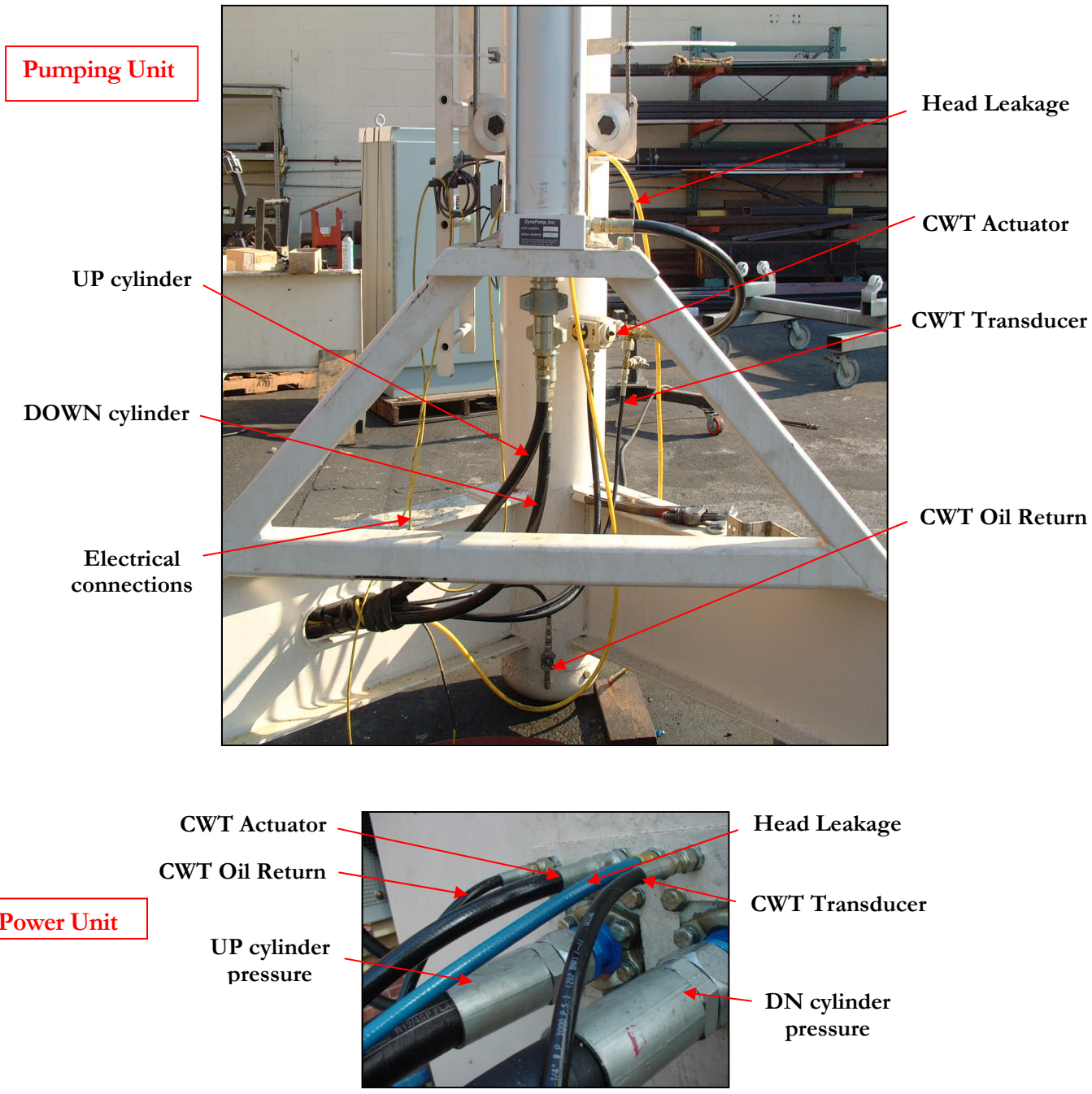


Figure 47. Power Unit to Pumping Unit Connections

Install the following connections between the Power Unit and the Pumping Unit:

> **⚠ WARNING:**
>
> ***When installing hoses and connections, it is imperative that the connection is clean on both ends. Any dirt or contamination introduced while making the connection can have an adverse affect on the operation of the pump and may lead to pre-mature failure of the pump or cylinder.***

1. Attach **Up** and **Down** hydraulic hoses between the power and pump unit (Figure 48).

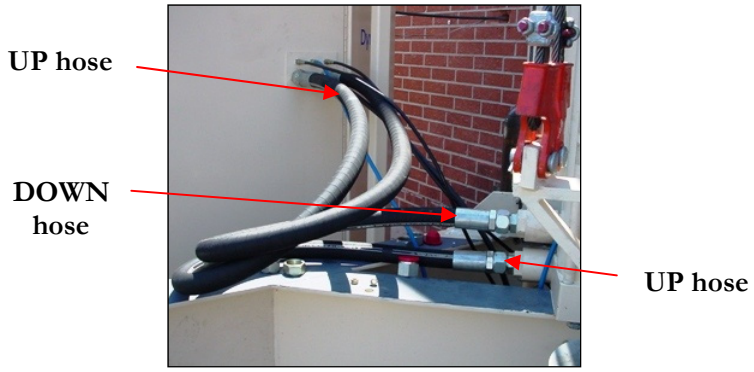


Figure 48. Hydraulic Hose Connections

2. Remove the caps from the counterweight chamber on the cylinder.

> **⚠ CAUTION:**
>
> ***The cylinder might not be fully retracted due to pressure in the counterweight unit, so remove cap slowly to prevent injury.***

3. Install one end of the **Up** chamber pressure hose to the power unit **Up** cylinder port, and the other end to the pumping unit cylinder **Up** port.
4. Rotate the hose so that it makes a smooth transition between the two units.
5. Make sure that the o-ring is properly installed and that the four bolts on each fitting are tight to prevent leakage.
6. Install one end of the **Down** chamber pressure hose to the power unit **Down** cylinder port, and the other end to the pumping unit cylinder **Down** port.
7. Rotate the hose so that it makes a smooth transition between the two units. Make sure that the four bolts on each end are tight to prevent leakage. Torque the bolts to 65 ft-lbs.
8. Manually open the **Up** and **Down** ball valves at the cylinder to allow the hydraulic pressure to equalize.
9. Slowly bleed the air and then remove the protective cap on the cylinder air fitting. As the air pressure is bled, the cylinder ram slowly descends until it reaches the bottom stop.

10. Connect one end of the Oil Return hose to the Power Unit and the other end to the 3/8-inch fitting on the front counterweight charge valve (See Figure 49). Torque to 35 ft-lbs. Once the hose is connected, open the charge ball valve.

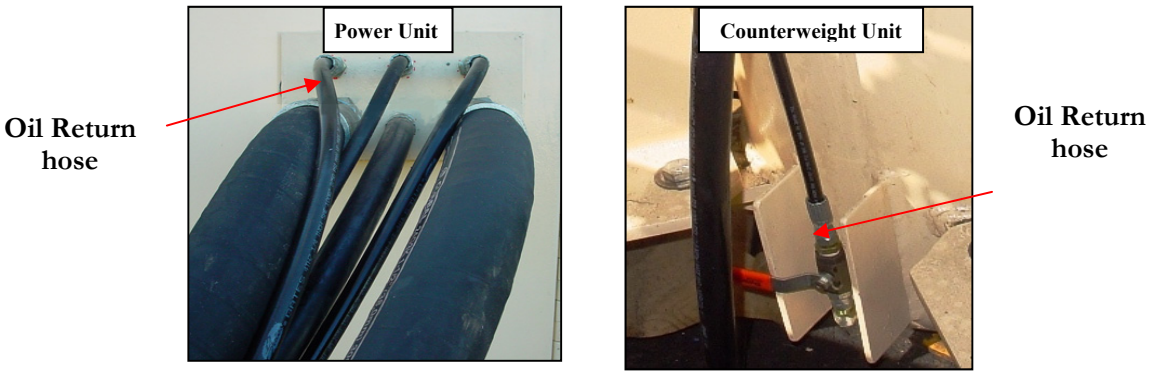


Figure 49. Oil Return Hose Connections

11. Connect the Head Leakage hose to the power unit. This hose that connects to the very top of the cylinder (see Figure 50). Torque the fitting to 50 ft-lbs.

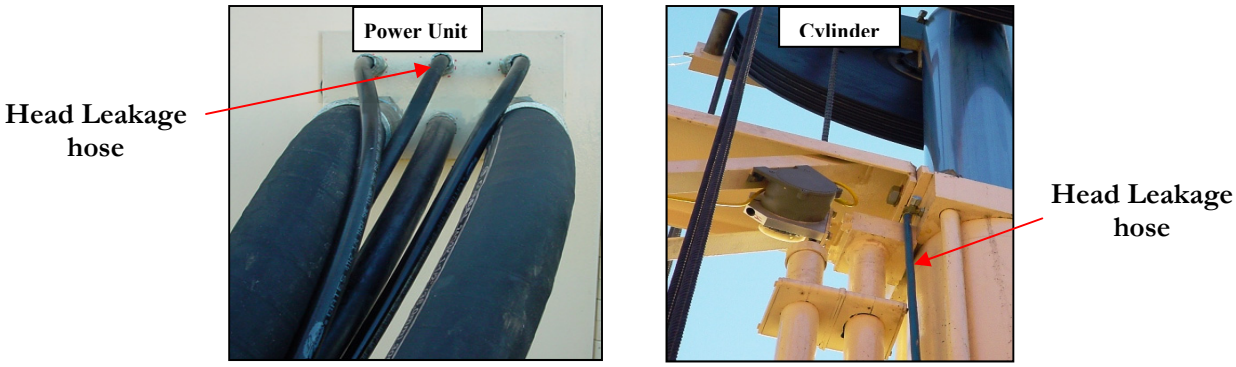


Figure 50. Head Leakage Hose Connections

12. Connect the Actuator hose from the Power Unit to the 1/2-inch JIC fitting on the front counterweight actuator (See Figure 51). Torque fitting to 50 ft-lbs.

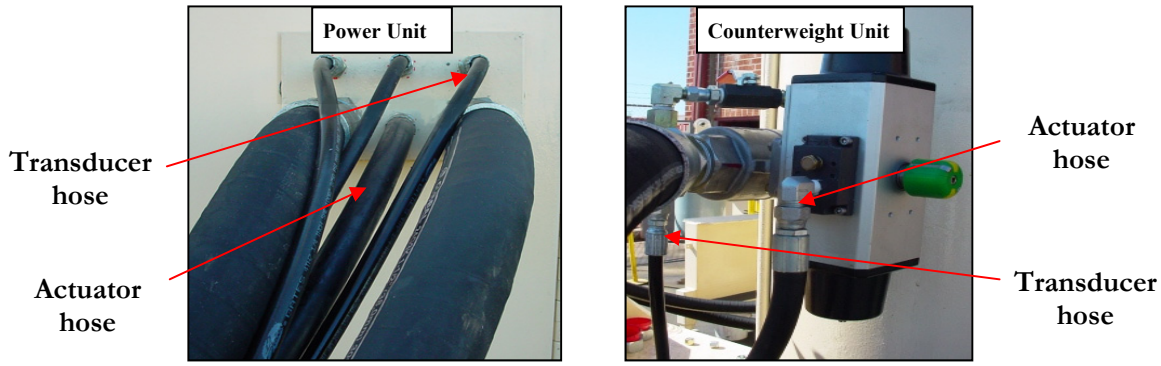


Figure 51. Actuator Hose Connections

13. Install the counterweight transducer hose from the power unit to the 3/8-inch JIC ball valve fitting on the front counterweight actuator. This hose allows the air pressure in the cylinder air up chamber to be measured. See Figure 52.

Figure 52. Transducer Hose Connections

14. Verify that the ball valves are open when monitoring for downstream fitting leaks during the filling process by applying soapy water and looking for bubbles.

15. Once the unit is charged, close the charge ball valve and terminate the charging process.

16. Detach the solenoid coil from the control manifold block by loosening the attachment nut to prevent inadvertent counterweight actuator energization (see Figure 53).

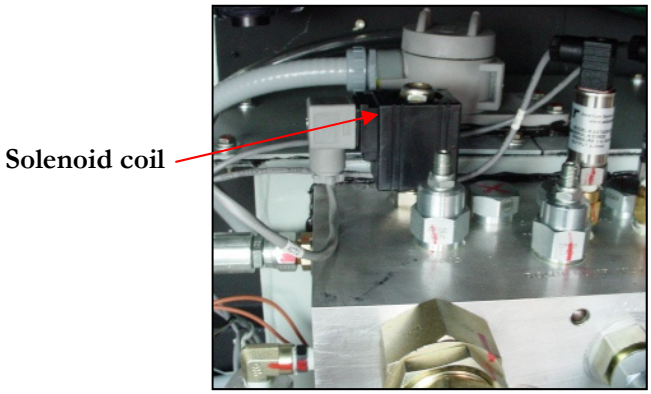


Figure 53. Detaching the Solenoid Valve Coil

17. Connect the two electrical cables from the pumping unit to the power unit. This cable provides the signal feedback necessary for the electronics to control the unit. See Figure 21.

18. Stretch the cable out and connect it to the connector on the pumping unit base, just below the cylinder.

19. Connect the green ground strap from the power unit to the pumping unit using the wire and ground receptacle shipped with the pump. The ground wire must also be connected the nearby ground rod installed earlier.

20. Install the roller assembly (P/N 11545) by attaching it to the base I-beam such that the roller is positioned under the "**Up**" or "**Down**" high-pressure hoses. The roller will protect the hoses from chafing as they flex under normal operation.

Check Tightness of all Bolts and Connections

During transport and installation of the equipment it is possible that screws and bolts may have loosened and therefore may result in improper operation of the unit.

- Check that all bolts and screws are properly tightened prior to going to the startup phase.
- Verify that the motor coupling setscrews are tight. Be sure to reinstall the motor guards after checking coupler setscrews.
- Verify that all screw connections in the electrical cabinet and in the electrical safety switch box are tight.
- Verify that all fittings and hose connections are tight, including those in the hydraulic cabinet.
- Verify all turnbuckles are secured with the locknuts provided.

Checking Phase Orientation of Wiring

Use the following procedure to check the phase rotation of the wiring:

1. Inside the cabinet, press the Oil Cooler Fan Motor Starter button (See Figure 54).

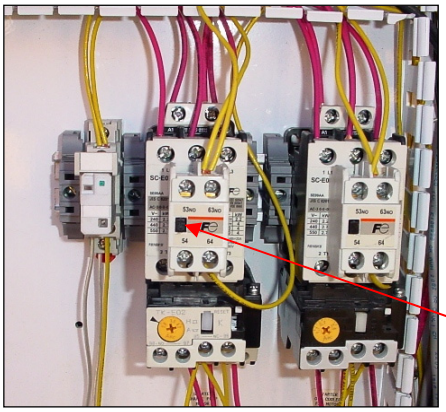


Figure 54. Oil Cooler Fan Motor Starter

2. Verify fan rotation is counterclockwise from inside the cabinet (see Figure 55).

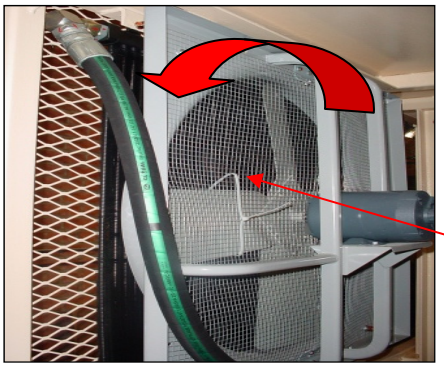


Figure 55. Oil Cooler Fan

3. If rotation is in the incorrect direction, change two of the L1-L2-L3 connections (see Figure 56). The input junction box is most commonly referred to as the MCCB.

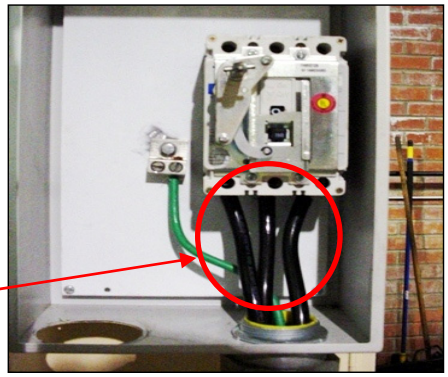


Figure 56. MCCB L1-L2-L3 Connections

External Shutdown Option

Customers may install an "external shutdown" for their equipment by altering existing DynaPump electrical circuitry. External shutdowns are commonly connected to flow line pressure switches, reservoir level switches or other sensor monitoring conditions. There are no new DynaPump parts required to perform this function.

> ⚠ **NOTE:**
>
> ***This external circuit requires external components and must be a "dry circuit" connection, meaning it must NOT supply voltage and, in most cases, depends on a relay to turn the connection ON and OFF.***

Perform the following procedure:

1. Safely remove power at the junction disconnect and discharge panel components.
2. Identify applicable power unit model and terminal block location on panel.

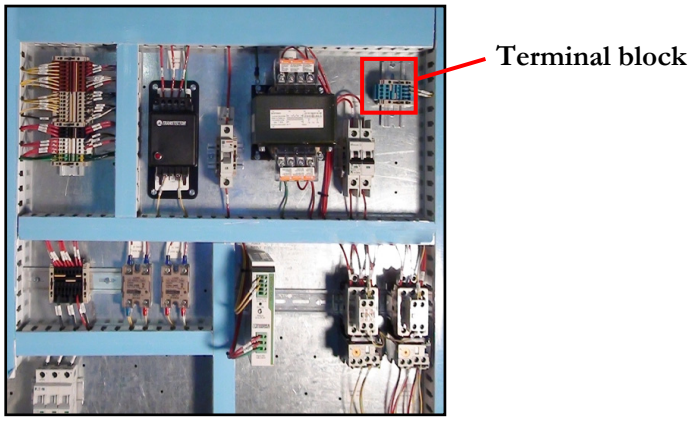


Figure 57. Electrical Panel Location of Shutdown Circuitry

3. Remove the yellow bus bar from the terminal block and attach external circuit wires on both sides of the corresponding connection.

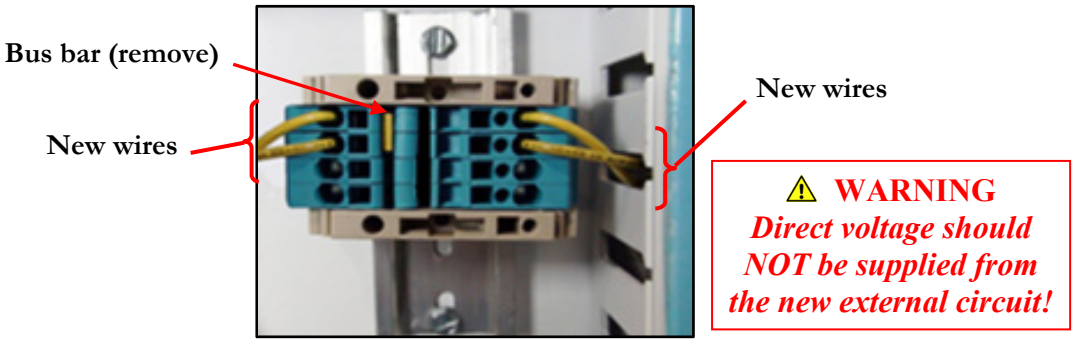


Figure 58. Terminal Block – New Wire Insertion Location

Section 6. DynaPump Service

Service

DynaPump has capable sales and service personnel placed strategically throughout oil producing areas of the world. Service personnel are competent and experienced in defining the proper size DynaPump model to use for particular well conditions and are well trained in installation, troubleshooting, and maintaining all DynaPump model pumps.

Repair and Replacement Parts Service

Commonly used spare parts for repair and replacement are available and in stock at local service centers inside the United States, and internationally through a distributorship network. A complete line of parts is also available from the manufacturing plant in Northridge, California. Outside the United States, Dynapump uses qualified, trained distributors to sell, repair, refurbish and provide warranty service to Dynapump equipment.

Contact the DynaPump sales office nearest you to inquire about the availability of DynaPump replacement parts and service. When ordering replacement parts, please specify the part number, the part description, and the Pumping or Power Unit model and serial number that the part will be used on.

Domestic Sales and Service Office: (281) 973-0050

Domestic Sales and Service Office (Fax): (281) 220-6492

Appendix A - Site Layout & Installation Drawings

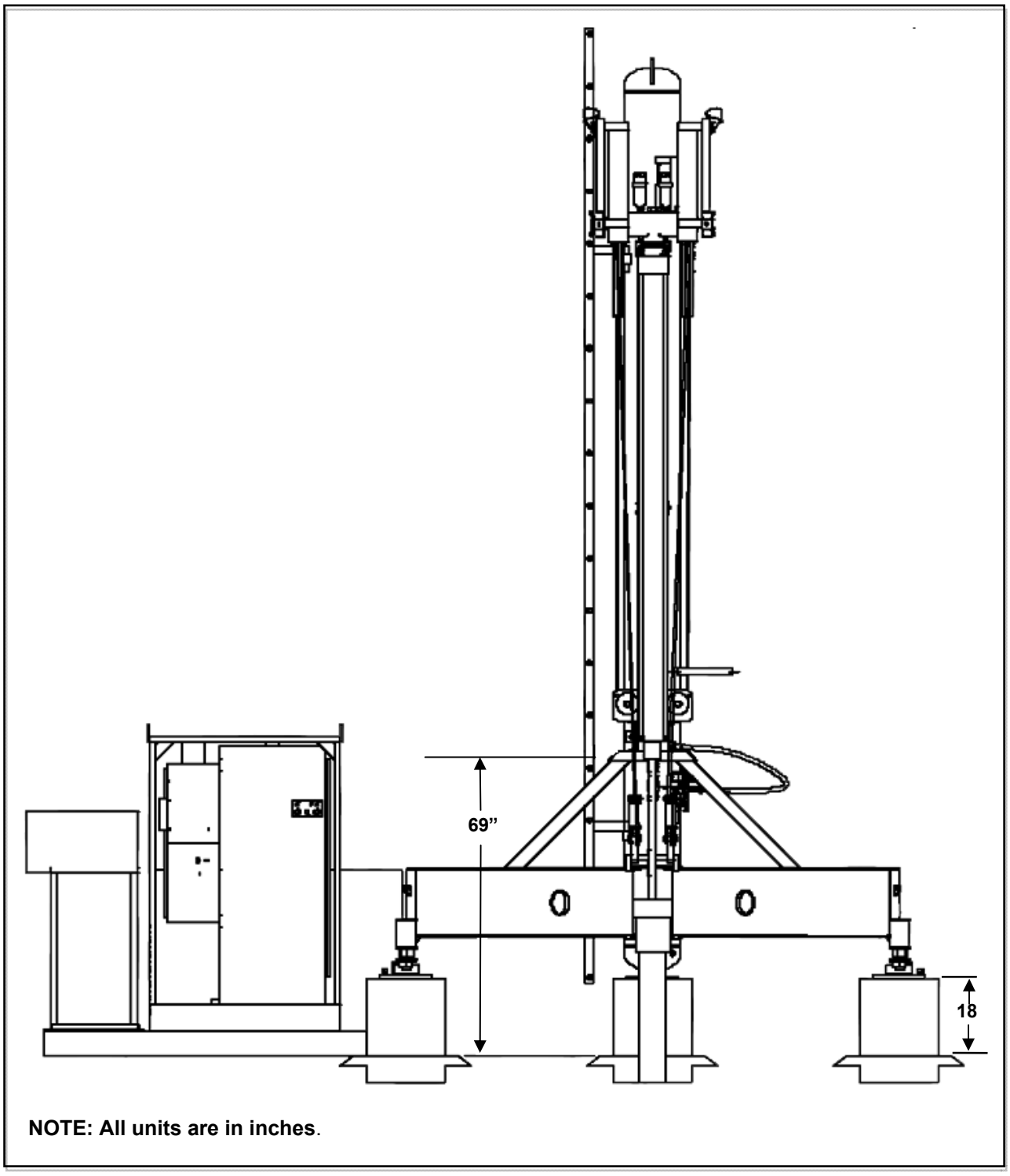


Figure A-2. Pier Layout (Front View)

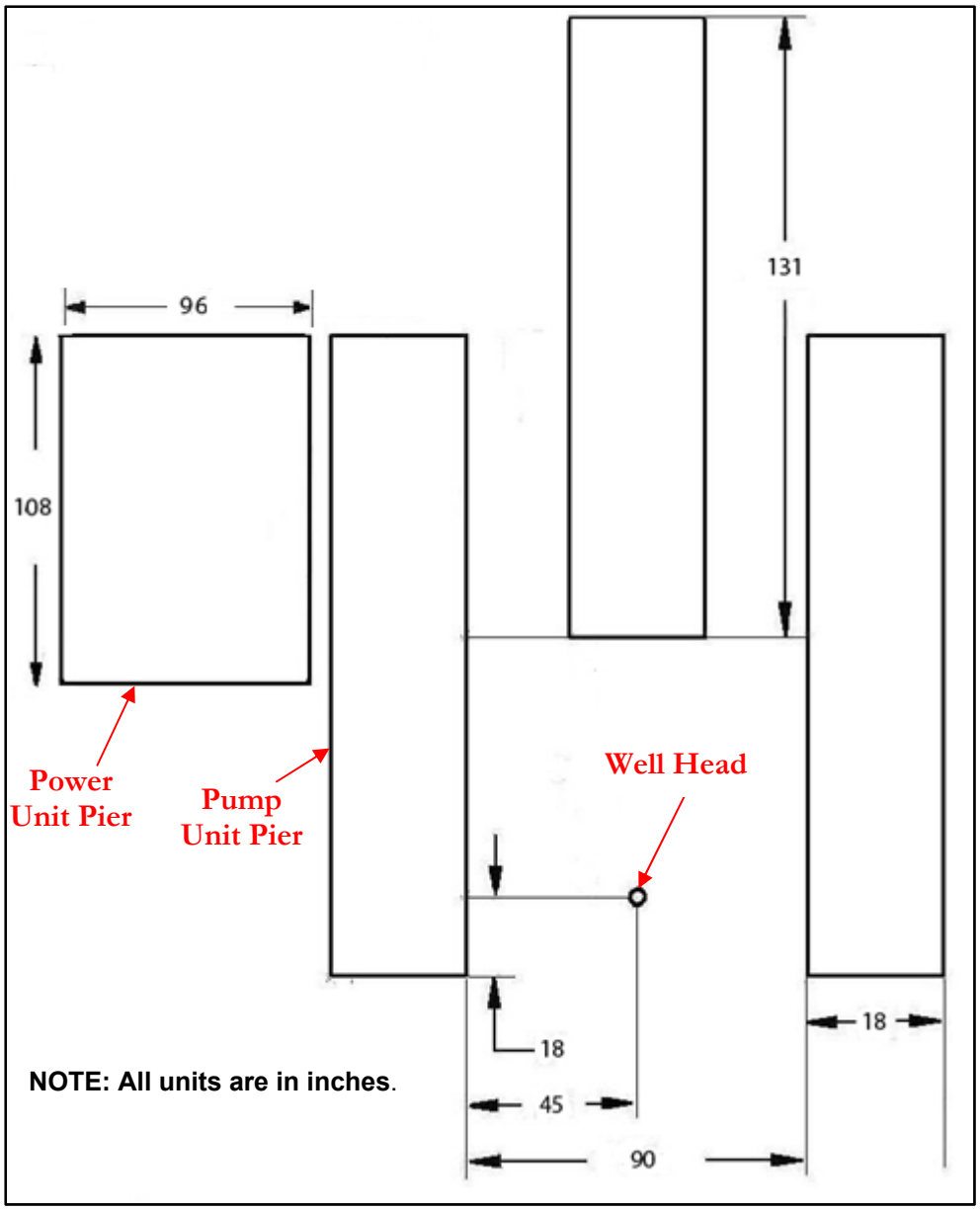
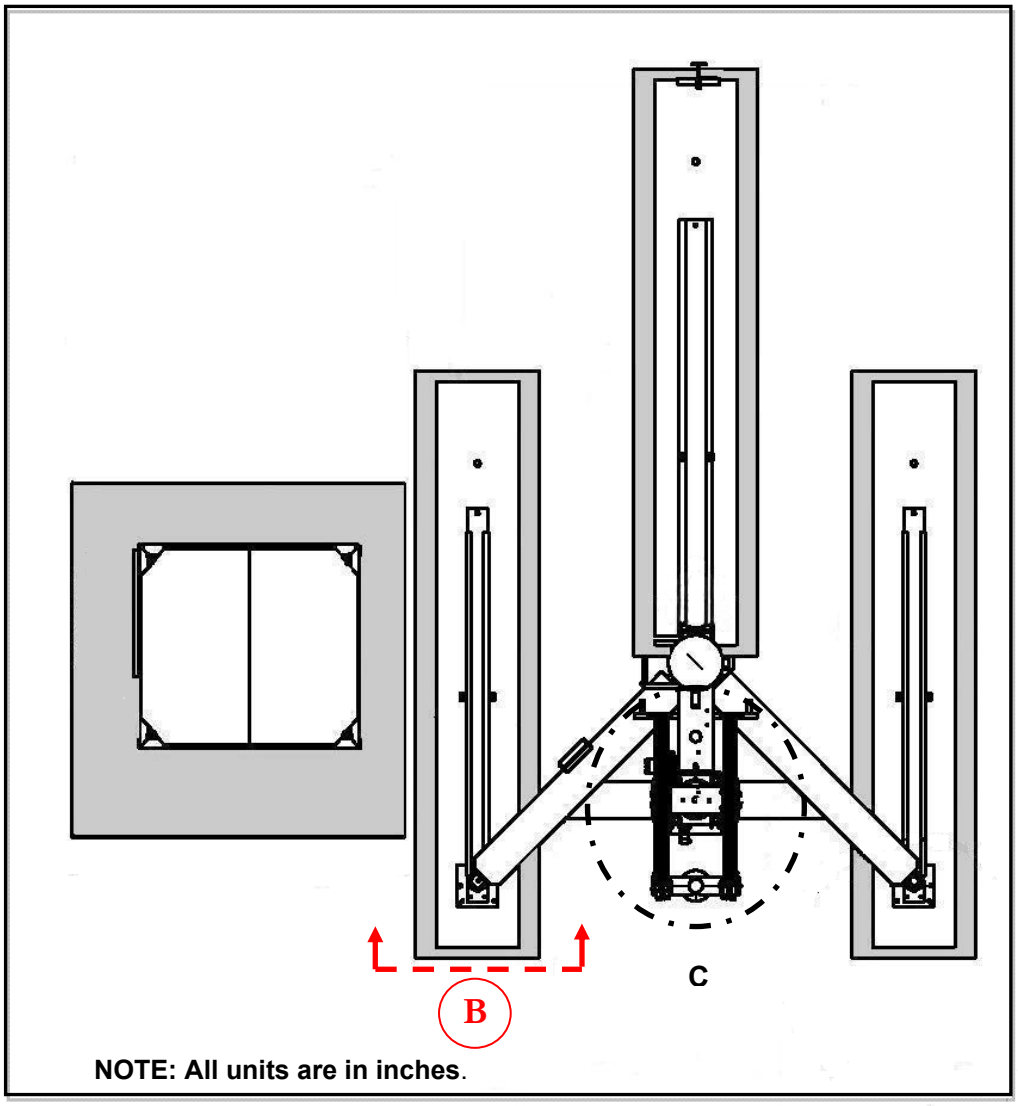
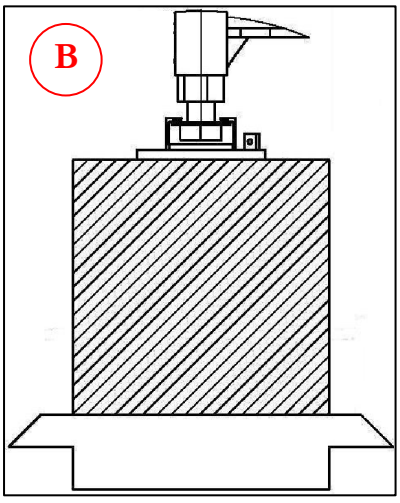


Figure A-3. Pier Layout (Top View)





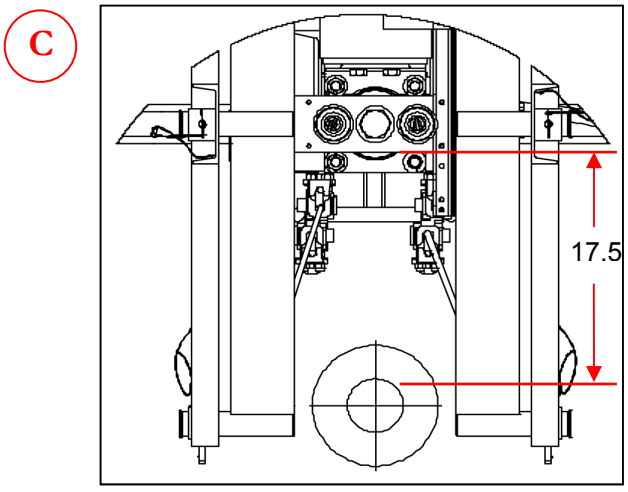


Figure A-4. Skid Installation on Piers

Appendix B - Installation Checklist

INSTALLATION _____ DATE _____

OFFICE # _____ POWER UNIT # _____
CONTACT _____ PUMPING UNIT # _____
EMAIL _____ CYLINDER # _____
CELL # _____ PULLEY # _____
FIELD WELL _____ GPS LATITUDE _____
GPS LONGITUDE _____

State & County unit is insatlled in (Needed for sales Tax) _____

W E L L D E T A I L

Rod Type	Dia	# of Rods	Length	T Length
Polish Rod				
Rod				
Rod				
Rod				
Sinker Bar				

VERTICAL DEPTH _____
BHP DIA _____
BHP BRL LENGTH _____
SURFACE PSI _____
ROD STRING API _____
DESIRED FLOW _____
Deviation _____

Enter the rods in the correct order from top to bottom

ROD LENGTH _____

Rod Detail to Vert Depth _____

ITEM	DESCRIPTION	COMPLETED
1	Set cement piers	☐
2	Verify top of power unit pad is 12" above cellar or ground level around well head	☐
3	Install skid system	☐
4	Install ground (Special grounding for linear scale)	☐
5	Check makeup motor amp rating and heater block setting	☐
6	Check fan motor rotation	☐
7	Check ladder logic for latest software version	☐
8	Check CPU calendar	☐
9	Set second communication port	☐
10	Calibrate temp transmitter to sight glass temp gauge	☐
11	Check installed parameters	☐
12	Install breather cap on hydraulic tank	☐
13	Check tightness of hydraulic filter	☐
14	Check all relief valves for proper adjustment.	☐
15	Check for hydraulic leaks	☐
16	Check motor alignment	☐
17	Check motor grease (Main motor/makeup motor/fan motor)	☐
18	Remove main motor mount shipping bolts	☐
19	Check CWT oil return	☐
20	Check CWT transducer and CWT hose connection for leaks	☐
21	Before startup check brake resistor & inverter exhaust shoot for nesting	☐
	PUMPING UNIT	
22	Lube cables	☐
23	Wipe down all debris from exposed cylinder ram	☐
24	Install rear CWT	☐
25	Install ladder	☐

Figure B-1. Installation Checklist (Sheet 1 of 3)

INSTALLATION CHECKLIST (Cont'd)

INSTALLATION _____ **DATE** _____

26	Install communication hose b/w CWT pipes, Open valves and check for leaks	☐	
27	Install and turn on lubbers	☐	
28	Align unit over well head	☐	
29	Rivet stop plates for skids	☐	
30	Check linear or rotary for zero position and remove packing retainer material	☐	
31	Install electrical connection between power & pumping unit	☐	
32	Install all hoses between power & pumping unit	☐	
33	Purge air from CWT actuator hose	☐	
34	Install base tie downs	☐	
35	Adjust cable length and check with tensioner	☐	
36	Check cotter pins on carrier bar and cable wedges	☐	
37	Install rod rotator (If required)	☐	
38	Install flow meter (If required)	☐	
39	Drain water from front and rear CWT pipes	☐	
40	Open CWT oil return ball valve	☐	
41	Test CWT oil return	☐	
42	Bleed air from cylinder up/down chambers	☐	
43	Check all hoses for leaks	☐	
44	After start-up check loads and settings for further adjustments	☐	
45	Create DP report	☐	
46	Email DP report to factory	☐	
Cold Weather Check Points			
47	Adjust min. start and run temperatures to local temp ranges.	☐	
48	Increase oil return pulse time by 3 seconds for below 40° F	☐	
49	Set electrical cabinet internal thermostat to 25° F	☐	
Test Settings and Adjust as Needed			
50	Check V3003 for default value	☐	
51	Activate V2046 and then adjust POC to load	☐	
52	V2070 - may need adjusted to activate POC	☐	
53	Warnings V2044 & V2045 - need adjusted 200 less than alarms	☐	
54	2032 & V2033 - need adjusted based on pressure graph	☐	
	POST-INSTALLATION FOLLOW-UP	**24 HR**	**72 HR**
55	Check all hardware for tightness	☐	☐
56	Check for hydraulic leaks	☐	☐
57	Check with customer for flow requirements and make adjustments	☐	☐
58	Check loads and settings for further adjustments	☐	☐
59	Email DP report to electronic distribution list (see above)	☐	☐
60	Pass software to customer personnel	☐	☐

SERVICE TECH_____ **DATE:**_____

Figure B-1. Installation Checklist (Sheet 2 of 3)

INSTALLATION CHECKLIST (Cont'd)

INSTALLATION _____ **DATE** _____

INSTALLATION NOTES AND EVALUATION

All items below must be filled in and returned to factory.

Did all equipment arrive on location on time?	YES	NO
What was the condition of the equipment when it arrived ?	YES	NO
Were any items missing?	YES	NO
Did everything go together OK?	YES	NO
Were there any problems with the assembly and start-up?	YES	NO
Was there any customer comments or suggestions for improvement?	YES	NO
Do you have any suggestion for improvement?	YES	NO

Additional Notes

Figure B-1. Installation Checklist (Sheet 3 of 3)

Appendix C - Historical Configurations

This appendix contains past data and configurations.

Page 4:

Section 2. Site Preparation

The three pumping unit piers are dimensioned **18" x 18" x 131"** and are positioned at a pre-established distance from each other. The power unit pier is dimensioned **92" x 60"** and is placed two to 10 inches from the pumping unit pier.

Page 8:

Section 4. Unpacking and Pump Unit Preassembly

Pumping Unit Final Assembly

1. Install the transducer into the cylinder support using two 5/16-inch screws (see Figure 3).

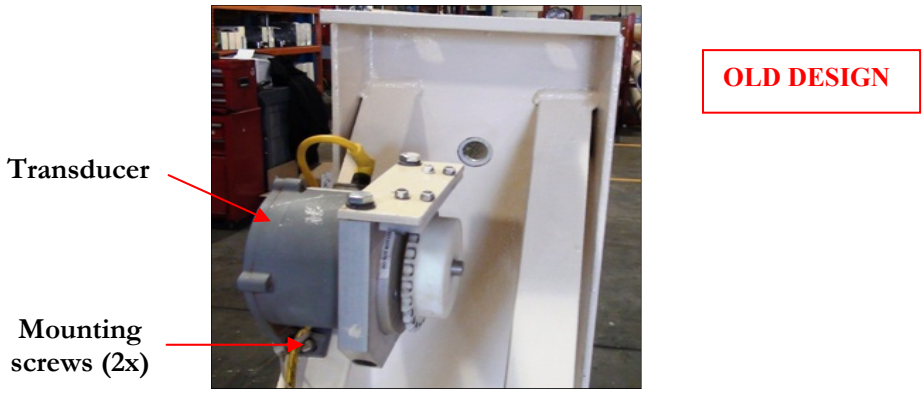


Figure C-2. Installing Celesco Transducer Assembly

13. Loosen the transducer mounting bracket to feed the chain over the sprockets of the transducer. When the chain meshes with the sprockets, reattach the bracket and secure with 7/16-inch screws (see Figure 15).

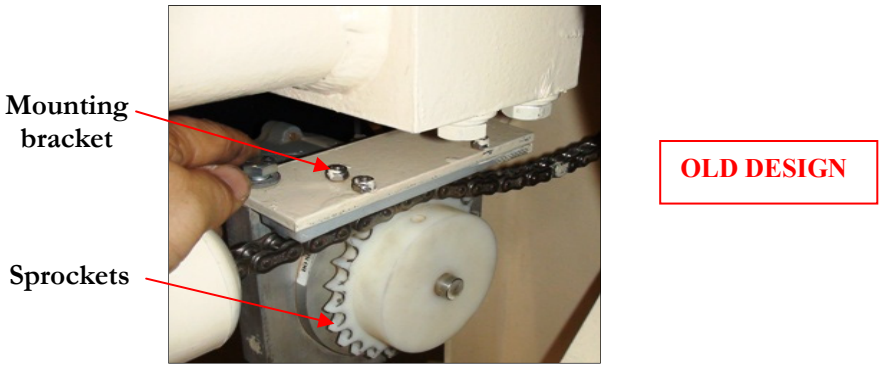


Figure C-3. Passing the Chain through Transducer Sprockets

17. Connect the electrical connection box via conduit to the sensor (see Figure 59).

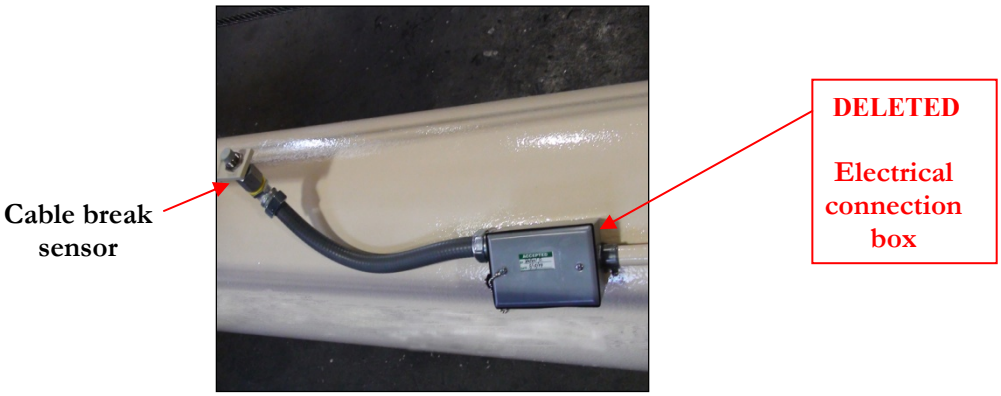


Figure 59. Electrical Connection Box

18. Electronically connect the transducer wiring (see Figure 60).

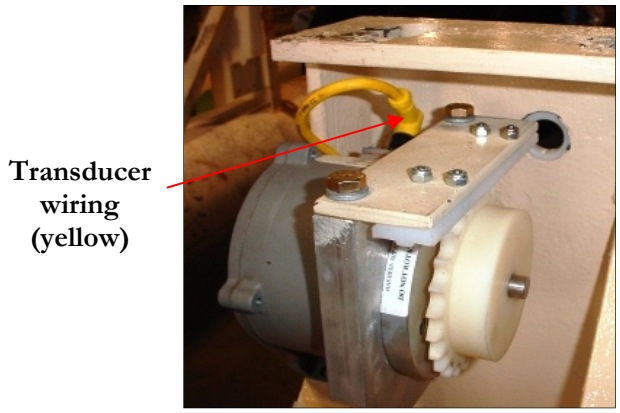


Figure 60. Transducer Wiring

19. Install electrical connections as diagrammed in Figure 21 below:

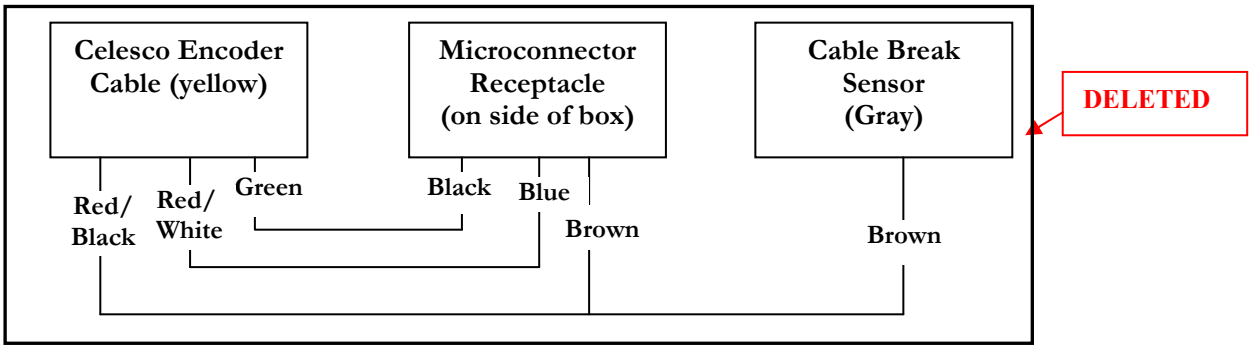
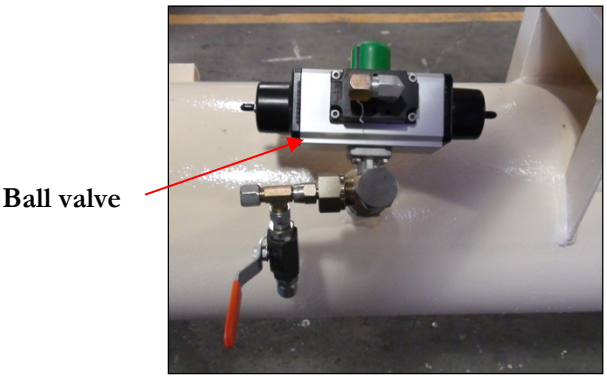


Figure 61. Electrical Wiring

31. Monitor the ball valve fittings for leaks during the filling process by applying soapy water and looking for bubbles. Verify that the ball valves are open when monitoring for leaks to test the downstream fittings up to the cap.



OLD DESIGN

Figure 62. Counterweight Actuator Ball Valve

Page A-2:

Appendix A. Site Layout & Installation Drawings

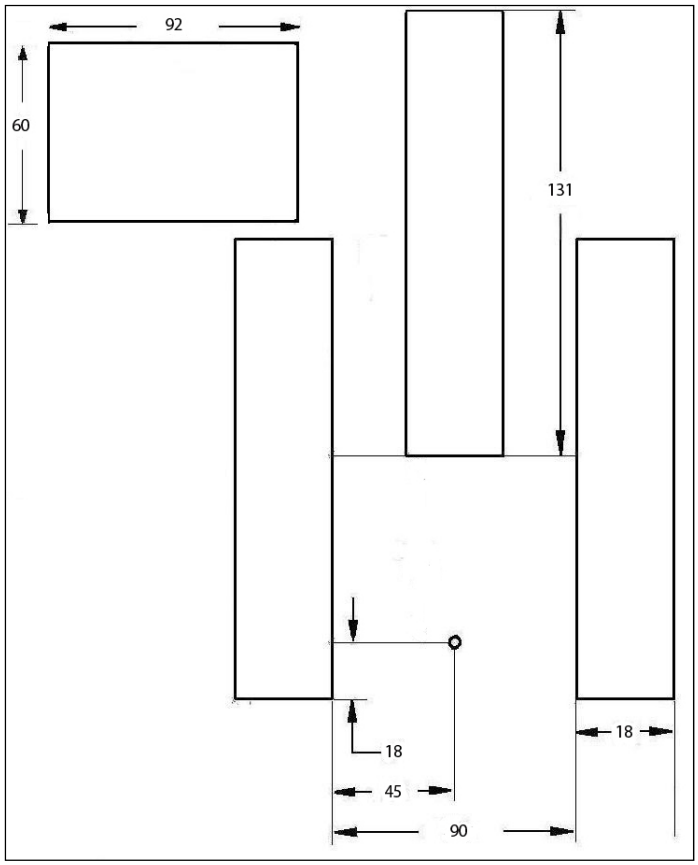


Figure A-3. Pier Layout (Top View)